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Hold Your Nose

IT WAS war time. We had been hustling for subscribers for Liberty Bonds. Passing from labor to refreshment at the local club, one of the prominent citizens who had just returned from Washington recounted his experience, with many strictures upon the Administration.

His concern had been asked for a bid upon an article that it manufactured, "And the chumps," he said, "are paying us nearly twice the regular price for them."

And he was taking it and bragging about it, and in all that goodly company nobody turned his back upon him; for was he not a prominent citizen, and had we not been selling Liberty Bonds for just such purchases?

The newspapers are full every day of accounts of hold-ups, usually accompanied by violence, often by murder. Occasionally, one of the crooks is apprehended. Instead of being made the subject of general abhorrence and treated as nearly as a vigilance committee would treat him, as is consistent with certitude as to his guilt, men of high intellectual attainments and professional standing openly devote all their talent and invoke every possible resource to save his neck, and sentimental sobbers fill his cell with luxuries and flowers, and throw a halo of romance and chivalry around him that makes him the hero and the example for many an incipient gangster.

A group preëmpts a natural or jockeys about an artificial advantage and proceeds to play it for all it is worth. "This is ours. If you want some of it, this is our price," and instead of being treated like any other hold-up men, they are beatified for their foresight, initiative and industry.

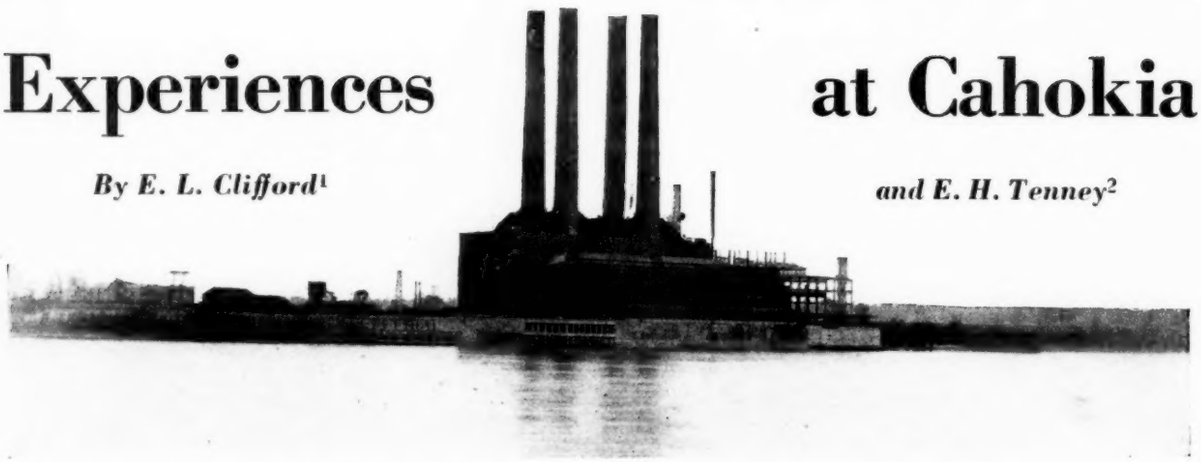
Another group, seizing upon some combination of circumstances that makes their services especially essential, conspires to put the whole public to inconvenience and loss in an effort for their own advantage, and orators prate of the "sacred rights of labor."

They all think they are right. It cannot be pounded or legislated out of them. The public has got to learn to recognize a crook as a crook, be his place high or low, and hold its nose when he goes by.

Ostracism and obloquy would make a lot of things very unfashionable that some people are thriving on today.

Experiences at Cahokia

By E. L. Clifford[1] *and E. H. Tenney*[2]



Cahokia at present as viewed from across the river

CAHOKIA was the second large central-station to adopt pulverized coal, and was a pioneer in applying this method of firing to low-grade coal. The first section of this station was described in *Power* Jan. 2, 1923. Again, the experience after a brief period of operation was covered in the April 1, 1924 issue. It is felt that publication at this time, of engineering development and operating experience after more than two years' operation, would be interesting and timely. At this writing the second section is complete, giving four main generating units in operation, with a total rated capacity of 145,000 kw. The substructure for the third section main building is complete, the structural steel framework erected, and orders placed for a 50,000-kw. turbo-generator, condensing equipment and switch gear for the fifth unit.

EARLY operating problems centered on the proper functioning of equipment and the breaking in of crews, for much of the design and equipment layout was new. Later, more attention has been centered on thermal economy. Before discussing these phases of operation, however, it will be of value to note the particular conditions at Cahokia which cause its operating problems to differ from those of other large stations. There is to be considered, first of all, the plant's relation to other generating stations of the St. Louis system and the resulting nature of the load. Located opposite the load center of the city, the plant is connected, through a substation, to Ashley Street Station on the opposite side, a mile and a half up the river, and the Keokuk hydro-electric station, some 150 miles north. Keokuk generates only 25-cycle power, Ashley Street both 25- and 60-cycle, and, since it is intended to limit the growth of the 25-cycle load, Cahokia generates only 60-cycle current, the two systems being partly interconnected through a 5,000-kw. frequency changer. Ordinarily, the newer and more economical plant would receive considerable aid during peak loads so as to enable it to operate at an advantageous load factor; but, with the reduced capacity of the hydro-electric plant in times of water shortage, Ashley Street must make up the difference in 25-cycle power, and, furthermore, a heavy central-district steam-heating load has recently been added to this plant. As a result Ashley Street is capable of giving less and less assistance in absorbing 60-cycle peak loads, and Cahokia generates approximately 95 per cent of the total 60-cycle output with an annual load factor, during 1925, of 44.3 per cent. As the economy of the total system is the determining consideration, Cahokia also carries the entire 60-cycle low power factor night load. In regard to electrical output, then, the station is favored with neither a base load nor a continuously high power factor.

The original analyses of engineering problems showed that low-cost coal from the Belleville, Illinois, district, was the most economical fuel then available, all factors of investment and operating costs considered. Changing market conditions since then, however, have made it advantageous to substitute varying amounts of other coals and, although about half of the coal consumed during the greater part of 1925 came from the Belleville district, the market now makes it advisable to burn Kathleen screenings. Analyses of Belleville and Kathleen coals are given in Table I, along with that of Youghiogheny, the latter taken as representative of high-grade Eastern bituminous coal.

While it is economically advantageous, all factors considered, to burn these low-priced coals, it should be borne in mind, when comparing its performance with other stations, that Cahokia is at a disadvantage, considering thermal performance alone, due to the poor quality of fuel.

In the combustion of pulverized coal the particular chemical and physical properties of the ash have proved important. With a coal such as that burned at Cahokia, whose ash fusing temperature is 2,000 deg. F., special methods of firing are required to prevent excessive slagging. Due to the iron and sulphur content of the ash, a flux is produced which causes the refractory walls to wash rapidly away. It has also been found that

[1] With McClellan & Junkersfeld, Inc., engineers and constructors.
[2] Chief engineer of power plants, Union Electric Light & Power Co., St. Louis, Mo.

flame travel and direction must be under control if sidewall erosion and the collection of slag in the lower generating tubes are to be kept at a minimum. Thus, until furnace and burner design has been perfected to meet these conditions, it will not be possible to operate with minimum amounts of excess air or at the desired high ratings. The changes in design made in the later sections of the plant for the purpose of meeting these conditions more exactly will be outlined later.

Although outweighing the disadvantages, the low cost of the coal burned at Cahokia does not warrant investment to secure the degree of refinement, designed to increase fuel economy, which is commonly justified for stations that have a higher fuel cost.

Another condition affecting operation to a marked degree exists in the condenser cooling water. The Mississippi has an extreme range in temperature of from 32 to 87 deg. F. Since there is a limit to condenser size and flexibility of circulator operation, there is a decidedly unfavorable increase in turbine back pressure in midsummer and an inevitable depression of hotwell temperature in midwinter. The extent to which the back pressure is affected may be noted by the curve Fig. 2.

Under the conditions outlined, operation was started in October, 1923. Without economizers and with a single bleeding point on each of the two main generating units, the plant, nevertheless, held the record among American stations for thermal performance during a part of 1924, until newer stations or additions were put into service with fuel and other conditions justifying economizers or similar refinements to secure greater fuel economy. Since that time the station performance has been further improved, the economy during February, 1926, being 16,729 B.t.u. per net kilowatt-hour delivered to the switchboard. Supporting conditions were 59 per cent monthly load factor, 66 per cent machine use factor and 45 per cent station use of plant or capacity factor.

Although justifiable improvements in mechanical design for the second section, which is now in operation, and for the third section, construction for which is under way, have been limited, on account of low cost of the fuel burned, numerous betterments have nevertheless been put into effect as indicated by experience since Cahokia was started in operation.

Improvements in the raw coal handling equipment, including the car dumper, have been chiefly suppression of dust and electrical interlock of conveyors, elevators and magnetic separator. The interlock of the drives for conveyor belts over the magnetic pulleys with the electrical circuit supplying the pulleys was provided to prevent tramp iron entering the pulverizing mills, which might occur if it were possible to deliver coal to the bunkers without magnetizing current on the magnetic pulley.

Careful design and training of operators, particularly in good housekeeping, are important factors making for safe operation. The subject of safety rules to be followed in design involves many detail considerations that cannot be adequately covered in this article, but reference may well be made to the excellent work done by committees of technical societies in promulgating safety rules, particularly those recommended by the National Fire Protection Association and adopted by the Underwriters. The effectiveness of precautions taken is best proved by the fact that, during more than two years of operation, there have been only comparatively light and harmless puffs, such as occasionally occur in spite of all reasonable precautions.

Early experience with the coal driers, which are of the type employing waste flue gases in direct contact with coal, showed the desirability of more effective drying and means of stopping fires which may occasionally develop in the driers. Improvements in drier construction made it possible to reduce the moisture content from an average of 11 per cent, in initial operation, to 8½ per cent, leaving the driers. Rearrangement of the mill relief vents permitted still further reduction of the moisture content of the coal leaving the mills to an

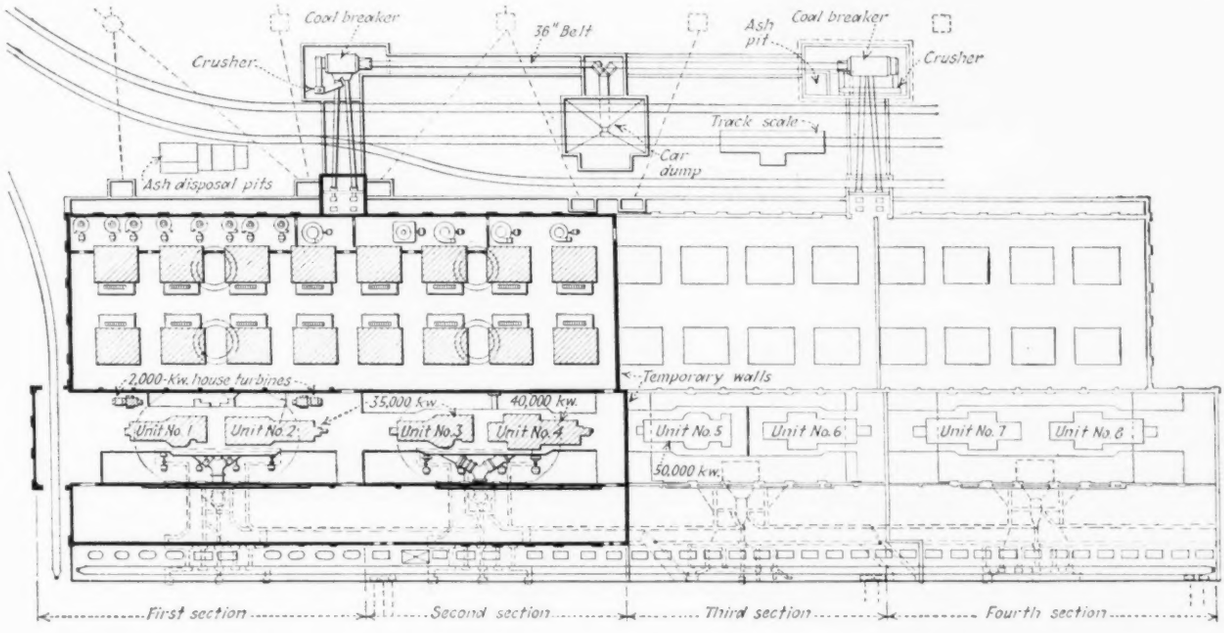


Fig. 1—Plan of main operating floor; first and second sections in heavy lines

average of about 5 per cent, the additional 3½ per cent gained in the mills resulting from breaking down the heated coal and the release of moisture that could not be readily removed in the driers.

Better drying and the installation of automatic feeds for the mills led to substantially improved milling and transport conditions. Further, after some experience with the initial eight 6-ton per hour mills, a 15-ton experimental mill of the same type was installed. This

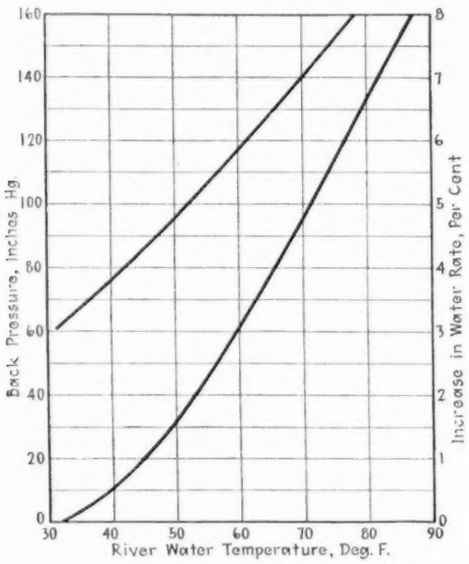


Fig. 2—Increase of station water rate with increase of river-water temperature

was followed by four mills of 15 to 20 tons per hour capacity completing the milling capacity through the second section.

The improvements and developments of drying and milling resulted in reduction of power consumption for milling from an average of 14.5 kw.-hr. per ton of coal pulverized during 1924 to 14 kw.-hr. per ton in 1925.

Fires and hot spots in the driers were brought under control and effectively overcome through the installation of tight closing gates for coal and gas connections to the driers. Baffles in the driers were also altered in such a way as to give an even flow of coal through the driers, avoiding pockets in which the coal might lie stationary and become excessively heated and dried so as to be particularly subject to spontaneous combustion.

Wear on exhaust-fan blades in connection with the mills at first appeared excessive and led to the trial of various materials such as cast ferralun and coatings of rubber, porcelain and glass on steel, but it was found that steel blades with a life of from 3,500 to 5,000 tons of coal ground gave the best results.

Likewise, efforts to overcome the wear of transport piping, especially at elbows, led to the trial of brass, lead and rubber linings, but the best expedient proved to be the use of special elbows with renewable cast-iron liners.

Cindervane fans for exhausting waste flue gases through the driers and cyclones on the discharges of transport system into pulverized fuel bins largely eliminated dust from these sources. It was finally found necessary, however, to equip the fan discharges with cyclones and further to carry vents from all the cyclones into the breeching in order to eliminate the small but annoying residue of fine dust that issued from the vents.

Partial enclosure of the car dumper suppressed much of the dust from this source, and a ventilating system, which is now planned for the breaker pit and raw-coal conveyor tunnels, is expected to result in improved comfort and operating conditions at these points.

Operation has now approached so nearly normal conditions that maintenance costs should not increase appreciably due to the age of equipment, and further improvements in economy of operation will be relatively small with the existing equipment. It is therefore possible to give some estimate of costs based on several months' continuous experience which indicates the total power consumption for raw-coal handling, milling and transport, including fans and air compressors, is less than 24 kw.-hr. per ton of coal consumed and that the total operating and maintenance cost, including power, for handling, preparing and transporting coal is less than 33 cents per ton. The maintenance cost of the coal preparation and transport systems is about 20 per cent of the total for the entire station. The greater portion of this is due to work on mills, the wear on which is heavy, due to the abrasive nature of the coal.

The largest single item of maintenance cost has been the repair of boiler settings. This represented about 33 per cent of the station total for maintenance during 1925. Of the total boiler outage the furnace linings were responsible for 70 to 90 per cent on the first eight boilers. This situation led to certain developments in furnace and burner design.

When the first section of eight 18,000-sq.ft. boilers was designed, but one other large central-station installation of pulverized fuel firing existed in the country and practically no knowledge was available on the use of Illinois coal in such form. Nearly all the existing installations were studied, however, and a series of tests were run with Illinois coal. With these data the first boilers were designed.

Briefly, the installation, as shown in Fig. 5, consists of a refractory lined furnace (0.65 cu.ft. combustion

TABLE I—COAL COMPARISONS

Coal	Belleville	Kathleen	Youghiogheny
Calculations (based on 1,000 tons of Youghiogheny)			
Coal burned, tons	1,400	1,270	1,000
Moisture, tons	146	136	23
Tota' ash, tons	278	162	78
Sulphur content, tons	70.0	31.8	15
Iron content, tons	69.6	38.1	2.9
Analyses			
Moisture	10.4	10.69	2.3
Volatile matter (dry basis)	37.9	37.7	28.0
Fixed carbon (dry basis)	39.9	48.0	64.0
Ash (dry basis)	22.2	14.3	8.0
Sulphur	5.0	2.5	1.5
B.t.u. as received	9,817	10,831	13,750
B.t.u. dry	10,957	12,127	14,074
Iron (in ash)	25	23.5	3.7
Fusing point of ash, deg. F.	2,000	2,010	2,300

Note 1. Analysis of Belleville coal is composite from 80 cars.
Note 2. Analysis of Kathleen coal is composite from 6,410 cars.

space per square foot of heating surface) with walls slightly tapering together toward the bottom so as to conform with the expected flame path and to radiate heat up into the combustion region and generating tubes. The ashpit and rear wall were protected by water screens with tubes set 11 in. on center, for it was realized that effective cooling would be required in these places. The side and front walls were hollow and cooled by the secondary air passing around the furnace in lanes and admitted through small openings in the front wall.

After a few months' operation, it was found that the

side wall brickwork was eroded away after an average of 2,000 hours' service, to a condition necessitating rebuilding. Experiments were immediately started with the burners and with various refractory materials in an effort to remedy the situation. In the way of refractories seventeen brands of firebrick and special materials were tried, but none proved greatly superior to ordinary first-grade firebrick, and it became certain that a scouring action of the flame, abetted by molten ash, was the outstanding cause. This conclusion was supported by the fact that arches (immediately above the burners) subject to temperatures equally as high as the side walls, but not subject to molten ash drippings, were not seriously affected and had given satisfactory service.

In the meantime four boiler units were being designed for the second section and, in line with previous experience, the side walls were made vertical with a view to reducing impingement against the walls of the end burner flames. As a result of this change and a few minor improvements in the tile-supporting construction, the life of the side walls was increased from 2,000 to 4,000 hours. Incidentally, the combustion space was increased to 0.685 cu.ft. per square foot of heating surface. The maximum continuous rating feasible, however, without injury to refractories was still limited to about 200 per cent, and even at this rating the percentage of excess air was increased somewhat over that for 150 per cent rating in order to reduce the severity of service on refractories.

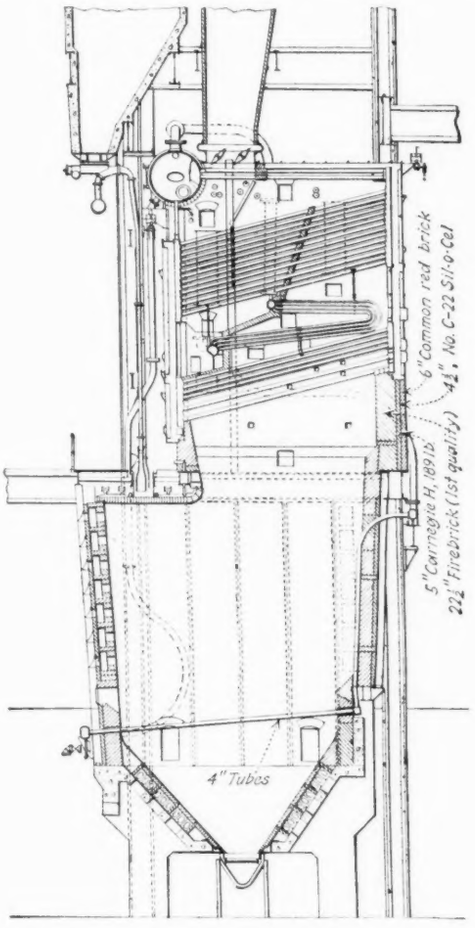


Fig. 3—Section through boiler and furnace No. 2

With the development and application of fin-tube walls initially to furnace No. 11 and subsequently to Nos. 4, 6, 10, 13 and 15, side-wall refractory troubles were largely eliminated in these furnaces and the problem centered on slag formation. This construction furnishes continuous water-tube or metal-protected surfaces across the sides and rear of the furnaces. With these furnaces ratings could be developed to the full extent of draft available, and the rate of B.t.u. liberation per cubic foot of furnace volume was limited only by smoke and slag formation. One disadvantage of this construction is the inability to avoid smoke while either a cold boiler is being brought up to load or ratings drop below 130 per cent. Also, the reduction in furnace temperature reduced the superheat and necessitated the installation of additional superheating surface.

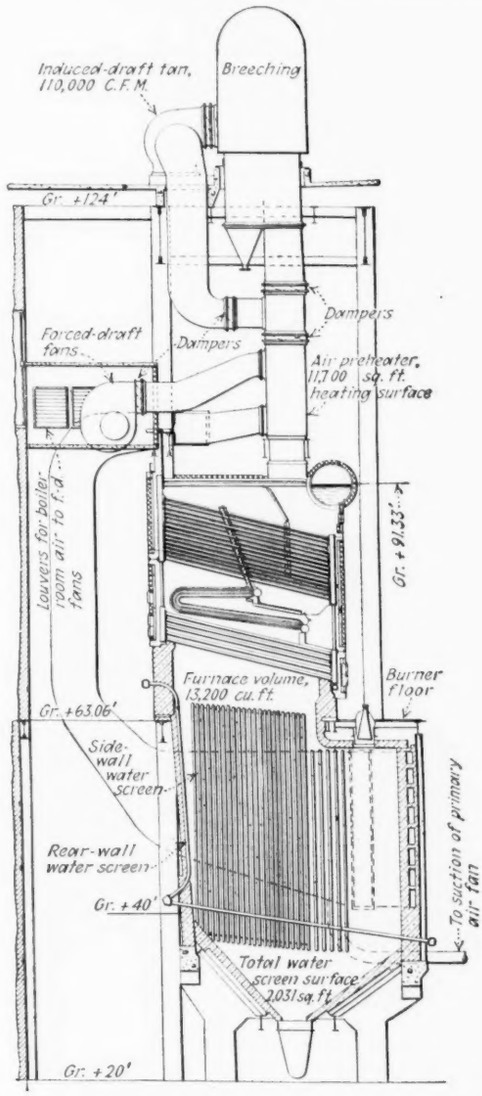


Fig. 4—Section through boiler and furnace No. 13

Another type of side-wall water cooling has been tried in two of the boilers, Nos. 14 and 16, in which plain vertical tubes are located between corbels of refractory. The furnace is not cooled quite so much in this type. Continuous ratings are limited to about 235 per cent. The life of the refractory is not as yet known, but after some eight months in service it is in good condition.

Experience with water-cooled walls is still too brief

to predict the life of the tubes, but it is certain that the service is severe. Some vertical screen tubes in one of the original furnaces required replacing after 8,500 hours of service in which the rating seldom exceeded 200 per cent. Tests have indicated that, at say 200 per cent rating, the water screens generate at very high rates. Under these conditions the proportion of steam to water in the vertical tubes, especially along their furnace side, is so great that cooling of the tubes is not always sufficient, with the result that some failures of vertical side and rear wall tubes have resulted.

There has been some concern as to the possibility of dissociation of highly superheated steam generated in these tubes leading to hydrogen embrittlement and corrosion by oxygen, but no positive indications. Owing to the high rates of evaporation in these tubes and also to the circulating connections which provide some local recirculation independent of the boilers proper, concentration of salt content of the water is rapid. Experience has demonstrated the importance of reducing condenser leakage into the hotwell and supplying only pure distilled water for makeup in order to prevent rapid accumulation of scale.

It appears that ample provision for expansion, pure feed water, adequate circulation and convenient means for cleaning are prime requisites for successful application of furnace water screens and must be supplemented by constant vigilance in operation. The present tendency toward higher rates of radiant-heat absorption makes these requirements increasingly important.

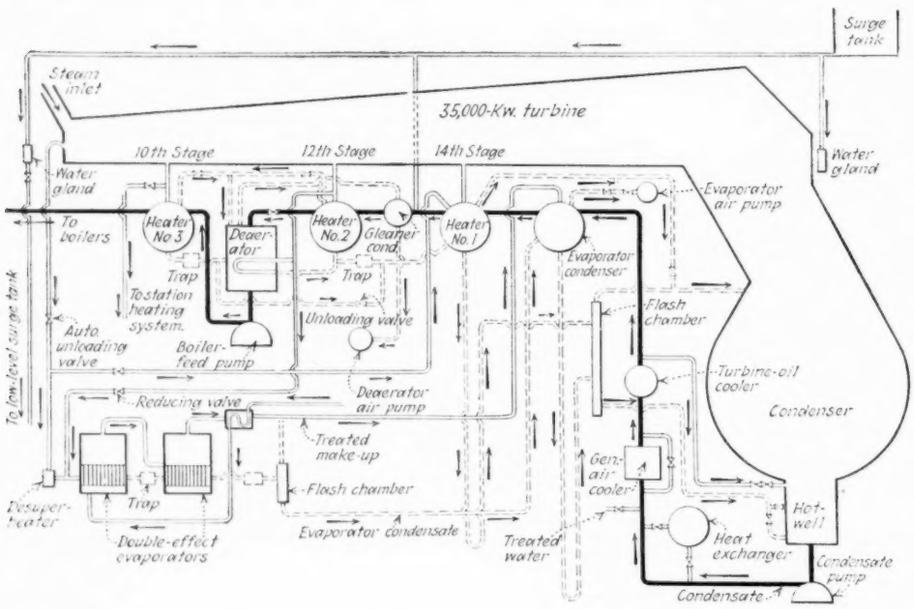


Fig. 5—Heat-balance diagram, unit No. 3

Smoke is a serious problem, but unavoidable only in the case of a cold boiler that is being brought up to load. Insufficient air or a flame travel up into the lower generating tubes may cause incomplete combustion and a consequent smoke condition, but this is controllable within the limits of available draft. In all the first fourteen boilers installed, the percentage of CO_2 was limited by smoke only at ratings below 150 per cent, and above this other causes, notably excess temperature, causing slag and melting refractory, limited the reduction of excess air.

Up to and including the water-tube screen walls, the furnace design has gone through a cycle of development which, for convenience, may now be summarized. Efficiencies and ratings in the original boilers were limited by refractories in furnace side walls which had an average life of 2,000 hours. Change in the shape of the furnace doubled the life of the side walls, but excess air and ratings were still governed by refractory limitations. The development of water-cooled side walls largely eliminated refractory trouble, excess air could be reduced to the point where slagging developed, and ratings were limited by the draft available; this last item also effected possibilities in flame control, the lack of which caused slagging or smoke.

Slag and Smoke Present Problems

The fuel conditions that entered the problem may be described in detail. In the firing of Illinois coal the control of slag formation is important. With proper fineness of pulverization excessive slagging is usually due to high furnace temperature and, consequently, it is necessary to maintain proper air and flame conditions if accumulation of slag in the generating tubes is to be avoided. It has been found that, once formed and not removed, a small collection of slag grows rapidly and that the best practice requires frequent air lancing. In the lower regions of the furnace, slagging of ash is likely to become serious if the flame is permitted to travel too great a distance through the water screen. On the whole the problem is one of vigilance, although changes in furnace design have effected improvements.

Air-Preheaters Installed

With this set of conditions existing, it appeared that an air-preheater installation with forced- and induced-draft fans would offer possibilities. It was believed that, in addition to the regular thermal gain due to preheated air, additional gains would result from (1) quicker ignition with a consequent greater use of combustion space and (2) better flame control with a consequent reduction in slag. The cooler furnace obtained with fin-tube construction would aid in operating at higher ratings. Consequently, with an improvement in slag difficulties and a possibility of greater use of combustion space, a continued higher rating would be possible. This would be highly desirable, for it would mean that along with higher steaming capacities there would be lower investment and maintenance costs. These considerations along with a higher efficiency would tend to more than offset the additional cost of the equipment per boiler.

The last two boilers of the second section were designed with air preheaters. These have been in service only a short time and complete information is not yet

available. A continuous rating of 370 per cent has been obtained without slagging the ashpit, and 300 per cent has been obtained with 14.5 per cent CO_2 at the top of the third pass. A section through boiler and furnace No. 13 is shown in Fig. 4. Table II gives the test results obtained with the various styles of furnaces.

TABLE II—COMPARISON CAHOKIA BOILERS TESTS WITH DIFFERENT FURNACES

Boiler Number	3	11	13	14
Type of wall	Refractory	Fin tube	Fin tube air preheater‡	Spaced tube
Rating for Best Efficiency				
Rating, per cent	150	185 (or below)*	190	185 (or below)*
Efficiency, per cent	86.00	86.75	87.10	84.85
Per cent CO_2 top 3rd pass	13.0	13.2	14.7	12.5
Total steam Temp., deg. F.	670	656	670	686
200 per Cent Rating				
Efficiency, per cent	83.50	85.50	87.08	84.20
Per cent CO_2 top 3rd pass	12.7	13.2	14.6	12.5
Total steam Temp., deg. F.	705	670	680	700
250 per Cent Rating				
Efficiency, per cent	81.00	81.40	86.90	81.70
Per cent CO_2 top 3rd pass	12.3	13.3	14.4	12.7
Total steam Temp., deg. F.	725	705	720	720
Maximum Rating Feasible				
Rating, per cent	200	260	340	235
Efficiency, per cent	83.50	80.70	81.50	82.50
Per cent CO_2 top 3rd pass	12.7	13.3	14.1	12.6
Total steam Temp., deg. F.	705	710	730†	720
Limiting factor	Brickwork	Drafts	....	Brickwork

*No test runs were made below this rating.
†370 per cent of rating has been successfully reached on No. 13 boiler but the efficiency drops off rapidly above 340 per cent rating and the furnace becomes rather hot
‡Efficiencies given for Boiler No. 13 are net, correcting for power consumed by forced and inducted draft fans.

Table III gives design data for the sixteen boilers of the first and second sections.

It may be noted that the grand total of heating surface of these boilers is 362,128 sq.ft., which gives a ratio of 2½ sq.ft. per rated kilowatt, the total installed rated capacity being 145,000 kw.

Boiler and Furnace Appurtenances

The study of burner design and position may be of interest. In order to protect refractory side walls, end burners have been tipped toward the center, but, on the whole, a straight vertical position has proved best. In all, three designs of burners have been tried: (1) The original design of "fantail" or plain flat burner; (2) the same with corrugations or constrictions at the burner outlet, and (3) the "riffle" type. None of the original design is in use, as ratings were limited and the flame travel was too long. Constricting strips were first placed in the nozzle outlets of some of the plain burners so as to increase the primary air pressure and obtain better flame control; next, burners cast with corrugations, to give the same effect as the plain ones with strips, were installed; these changes permitted increased ratings without greatly affecting furnace conditions. The latest development, known as the "cast riffle burner," permits (or requires) still higher air pressure behind the burner, which pressure, together with the spreading feature of the burner outlet, produces a more uniform mixture of coal and air and a clearer flame. This type is being extended to all boilers. On the whole it appears that burner design has not reached its fullest development.

Control of the fuel feeders, which are driven in a group of ten for each boiler, requires attention of the operators in order to maintain uniform flame conditions across the width of the furnace. The wear on feeder screws is heavy; coal packs about the feeder screws unevenly and clutches occasionally slip. All or any of these conditions may result in uneven fuel feed. Gates of the louver type have been installed above each feeder, and an occasional turn of these gates assists in preventing the packing of coal.

Pulverized fuel ash is abrasive, and early in the operation of the boilers it was found that, when entrained and blown against tubes at high velocity by soot-blowers, it tends to cut. As a precaution sheet-steel shields are clipped over tubes where cutting tends to develop. The cutting shown on these shields indicates that this precaution is well worth while.

During the early stages of operation superheat exceeded the design figures and the total temperature averaged about 725 deg. F. instead of the 700 deg. contemplated. This was partly due to the fact that boiler efficiencies were lower than later reached in normal operation. Shadow tiles were installed and some tubes removed in order to keep down the superheat. With the improvement of efficiency the shadow tiles were removed. The boilers were designed for operating pressure of 350 lb. gage, but with the intention of operating initially at 325 lb. and with 300 lb. at the turbine throttles. Recently, the springs of the safety valves have been changed and it is intended to increase the operating pressure of the boilers to 350 lb. with a throttle pressure of 325 lb. and also to increase the superheat slightly but not exceeding 725 deg. total temperature.

TABLE III—BOILER AND FURNACE DATA—SECTIONS I AND II—16 BOILERS

	Boilers 1, 2, 3, 5, 7 and 8	Boiler 4	Boiler 6	Boilers 9 and 12	Boiler 10	Boiler 11	Boilers 13 and 15	Boilers 14 and 16
Boiler-heating surface, sq.ft. per boiler	18,010	18,010	18,010	18,010	18,010	18,010	18,010	18,010
Superheating surface, sq.ft. per boiler	3,090	4,070	4,070	3,090	4,070	4,070	4,070	3,090
Water-screen surface:							905 fin.	plain
Side-wall tubes, sq.ft. and type	None	500 fin.	525 fin.	None	525 fin.	940 fin.	206 fin.	1,020 recessed
Rear-wall tubes, sq.ft. and type	223 plain	223 plain	223 plain	296 plain	296 plain	566 fin.	540 fin.	502 plain
Bottom screen, sq.ft. and type	358 plain	358 plain	358 plain	454 plain	454 plain	382 plain	380 plain	503 plain
Total W.S. surface, sq.ft. per blr.	581	1,081	1 106	750	1 275	1,888	2,031	2,025
Total heating surface per blr., sq.ft.	21,681	23,161	23,186	21,850	23 355	23 968	24,111	23,125
Furnace volume per boiler, cu.ft	11,750	11,750	11,750	12,487	12,487	13,500	13,200	13,000
Furnace volume, cu.ft. per rated hp.	6.5	6.5	6.5	6.85	6.85	7.5	7.3	7.2
Distance arch to water screen	22 ft. 0 in.	22 ft. 0 in.	22 ft. 0 in.	22 ft. 6 in.	22 ft. 6 in.	22 ft. 6 in.	21 ft. 6 in.	22 ft. 6 in.
Width of furnace, top	17 ft. 10 in.	17 ft. 10 in.	17 ft. 10 in.	.....	.....	.....	.....	.....
Width of furnace, bottom	16 ft. 0 in.	16 ft. 0 in.	16 ft. 0 in.	18 ft. 8 in.	18 ft. 8 in.	20 ft. 9 in.	18 ft. 8 in.	18 ft. 8 in.

Note: Furnace volume measured from above center-line bottom screen to center-line of lowest boiler tubes.
Width of furnace measured between side walls or between *inner* faces of tubes.
Distance arch to screen measured vertically from intersection of center line of bottom screen and inside of front wall to underside of arch.
Fin-tube surface based on one half entire perimeter of fin and tube. Screen surface for boilers 14 and 16 based on entire tube surface.
Boilers 13 and 15 have air preheaters of approximately 11,700 sq.ft. of heating surface for each boiler, with forced-and induced-draft fans.

A water-sluicing ash-disposal system is used at Cahokia and has been subjected to severe service. In the first section of the plant a cast-iron trough was used for the sluiceway, but in the second section 24-in. standard cast-iron pipe was adopted and has now been extended to replace the trough in the first section. The pipe line gives better flow, it permits turning when worn and is easily replaced. In addition, renewable steel wearing plates have been installed and are effective in reducing maintenance. This system is convenient

and economical in operation. Considering the high percentage and character of ash handled, the maintenance cost is not excessive.

Steam Utilization

Turbo-generators Nos. 1, 2 and 3 have ratings of 35,000 kw. each, and turbo-generator No. 4, 40,000 kw., making a total of 145,000 kw.

In the heat-balance arrangements of the first section only one bleeder point from each of the two turbines was utilized for heating feed water and the deaërating feed-water heater was supplied with exhaust steam from the house turbine. As a result one of the house turbo-generators must be operated when either or both of the two main turbo-generators in the first section are in operation and the load adjusted on this house turbo-generator in order to obtain the most efficient heat balance and proper deaëration of feed water. Current in excess of that furnished by the house generators for auxiliary use in the first section is normally furnished by house transformers.

In the design of the second and subsequent sections it was desired to continue the advantage of being able to operate auxiliaries from the house turbo-generator with all main units shut down or with a main bus section dead. At the same time it was desirable, in accordance with recent developments, to improve the heat balance for the third and fourth units by heating feed water more completely with bled steam, utilizing three bleeder points for this purpose. Accordingly, the house generator bus in the first section was extended through the second section with selector connections thereto for certain essential auxiliaries, although normally all auxiliaries are supplied through house transformers. Thus, the required reliability of operation was obtained without installation of additional house turbo-generators in the second section, and at the same time a more efficient heat balance was attained.

Gland steam leakage from turbo-generator No. 3 is utilized for evaporator supply. One double-effect evaporator serves for both units Nos. 3 and 4, but there are separate evaporator condensers for each unit. The heat exchanger between the condensate pump and generator air cooler is not an ideal arrangement because its function is to extract heat from the condensate. Raw water is circulated through it for this purpose, but it is rarely used—only when the river-water temperature is extremely high and the condensate rises abnormally in temperature as a result of poor vacuum. It is then occasionally necessary to make use of it as the most convenient means of keeping the bearing oil and generator cooling air below safe temperature limits.

As the result of operating experience, improvements in the electrical equipment which increase reliability of operation have been made in the Second Section and have been made or are under way in the First Section. These include further enclosure of compartments and insulation of conductors for power leads and for potential transformers, gas-tight bushings for conductors passing through walls, increasing flashover insulation of bushing through floors and walls and provision of two circuit-breakers in series between bus sections permitting making dead each bus section before busbars enter adjacent bus chambers.

It is expected that further publications in the technical press will amplify some of the subjects here discussed.

A Problem in Pipe Connection

By W. T. McClenahan*

THE layout of pipe connections is easy when the whole assembly lies in a single plane, or when 90-deg. elbows are used, but in some cases this is impossible and other devices are necessary. While a pipefitter can easily arrange any unusual connections in the field and the draftsman can work out difficult problems by the simple methods of descriptive geometry, it may nevertheless be interesting to present the results of a mathematical analysis which develops fairly simple formulas applicable to any case.

Any possible case of pipe connection may be reduced to the simple situation presented in Fig. 1. Two lines of pipe approach the corner of a room along the adjacent walls, but at different levels. The angle between these walls need not be 90 deg.; in fact, it may be anything whatever. If both lines of pipe could be run all the way to the corner, a connection could be made with two 90-deg. elbows, and the length of this connection is the shortest distance between these two lines of pipe. If, on the contrary, it is impossible to run these lines into the corner, it will be necessary to connect them by a diagonal filler, as shown in the sketch. The problem is to determine where to cut the two lines of pipe, how

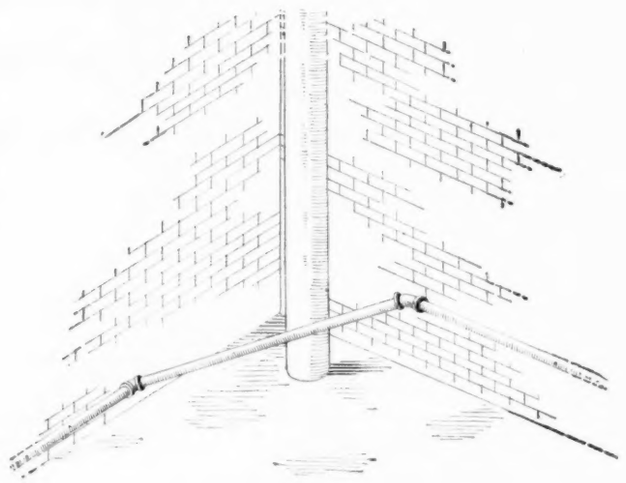


Fig. 1—Diagonal pipe connection

long to make the filler, and what the angle of the elbows must be.

The problem can be restated in mathematical language as follows: The relative position of any two lines in space is defined by the length of their mutual perpendicular, that is, the length of a line that is perpendicular to both of the lines in question (this is analogous to the short filler connecting two pipe lines with 90-deg. elbows), together with the value of the angle between these two lines, as seen by an observer sighting along the mutual perpendicular. Fig. 2 is a diagram of the situation. The mutual perpendicular is the distance c, and the angle between the lines is the angle C. Now let these two lines be connected by a diagonal l which intersects the lines at distances a and b from the mutual perpendicular and forms the angles A and B. By the methods of analytic geometry it is

*Hydraulic and Sanitary Engineer.

easy to write the three following equations, relating the various quantities indicated in Fig. 2:

$$l = \sqrt{a^2 + b^2 + c^2 - 2ab \cos C} \quad (1)$$

$$\cos A = \frac{a - b \cos C}{l} \quad (2)$$

$$\cos B = \frac{b - a \cos C}{l} \quad (3)$$

These formulas can be used for computing l, A and B when c, C, a and b are known. The result, however, will be useful only when A and B happen to work out

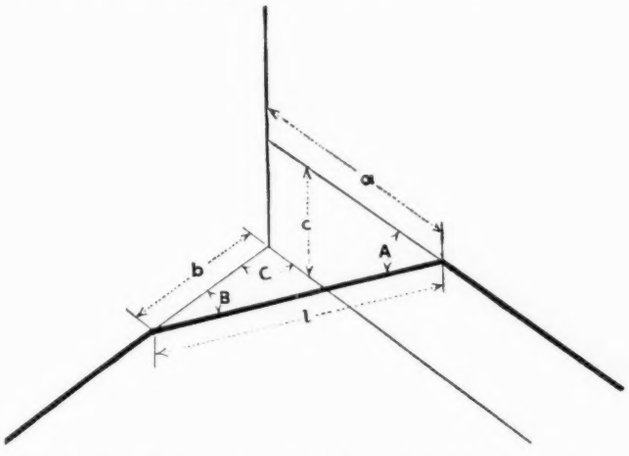


Fig. 2—Distances and angles related by formulas

to be angles that are available in standard fittings (22½ deg., 45 deg., 60 deg. or 90 deg.) or combinations of these (such as 22½ + 45 = 67½, 60 — 45 = 15, etc.) or when special fittings are to be made up. A more useful equation covers the case in which the dimensions a, b and l are to be chosen to permit the use of standard fitting angles at A and B. The equation for l may be transformed to

$$l = \frac{c \sin C}{\sqrt{-[\cos A + \cos (C - B)][\cos A + \cos (C + B)]}} \quad (4)$$

and this, together with equations (2) and (3), makes a complete solution possible when the angles are given.

The special case is interesting in which the angle C is equal to 90 deg. The formulas then reduce to the following:

$$l = \sqrt{a^2 + b^2 + c^2} \quad (5)$$

$$\cos A = \frac{a}{l} \quad (6)$$

$$\cos B = \frac{b}{l} \quad (7)$$

$$l = \frac{c}{\sqrt{1 - \cos^2 A - \cos^2 B}} \quad (8)$$

A study of these formulas is not without interest and yields information that is more or less common knowledge to experienced pipefitters and draftsmen.

In the first place it may be noted that the angles A and B are not independent. They are involved in the equations in such a way that their values are related, so that, as soon as one of these angles is assumed, the other is immediately restricted to a definite range of values. An interesting practical consequence of this is that even when the angle C is 90 deg., it is impossible to make a connection with two 45-deg. elbows unless the distance c becomes zero; that is, unless the two lines of pipe lie in the same plane.

In any case it is always possible to make a connection with two 90-deg. elbows; that is, with angle A and angle B each equal to 90 deg. Likewise, in any case, it is possible to lay out a connection with angle A equal to angle B. In this case it is more or less obvious that distance a must equal distance b, but the actual value of angle A = angle B may be anything between 90 deg. and 45 deg., depending upon whether $a = b$ = zero or infinity, respectively.

It would be interesting to study the matter further and transform the three equations to make them directly usable for various combinations of given quantities, but the pleasure of doing this must be left to the reader. It must suffice to remark that any combination of four given quantities will lead to a solution, if the three fundamental equations be properly handled.

In practice, calculations of this sort might serve as a rough guide, but would not ordinarily be worked out very accurately since the springing of the pipe and the leeway in setting up screwed joints would compensate for some inaccuracy in angle or length.

Combined Steam and Hydro Plants*

Co-ordinated systems of steam and water power are needed for the maximum use of water resources. It is also apparent that a 100 per cent water-power supply is not desirable, since this would mean that water powers would be developed for only the minimum flow of the stream and all the kilowatt-hours in the water in excess of the minimum would not be developed. In California, and in fact all over the world save in a few exceptional cases, the amount of such a minimum power is so small that it would not form a satisfactory supply for commercial power systems.

This condition of steam fluctuation emphasizes the futility of statements that are frequently made by economists, Congressmen, chambers of commerce, and others that a certain territory has a potential resource of a certain number of horsepower of water power. Without the qualifying knowledge of the amount of co-ordinating steam needed, such a statement is worthless as a measure of the value of the territory as a power producer. The whole economic situation from a power viewpoint must involve flow characteristics, cost of fuel, economy of steam plants and cost of plants of both kinds.

The high economies that have been obtained in the recently completed steam plant of the Los Angeles Gas & Electric Co. at Seal Beach, and the Southern California Edison Co. at Long Beach, have made a decided difference in the situation. While the older steam plants in California have economies of 200 to 260 kw.-hr. per barrel of oil under full-load conditions, the economy of these new plants is of the magnitude of 425 to 450 kw.-hr. per barrel. At such efficiencies the fuel cost with oil at $1 per barrel ranges around 2½ mills per kilowatt-hour, a figure so low that additional stream-flow plants in California are practically out of the question, and plants having storage facilities must be scrutinized more carefully than heretofore. Only an increase of several hundred per cent in the price of fuel can change this condition.

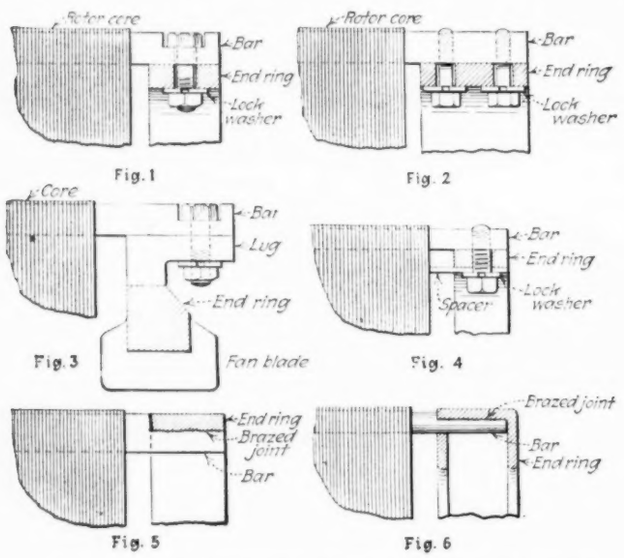
*Abstracted from a paper by H. A. Barre, presented at the Spring Meeting, San Francisco, Calif., June 28 to July 1, 1926, of The American Society of Mechanical Engineers.

Alternating-Current Motors—Squirrel-Cage Rotors—I

Materials Used in Rotor Windings — Effects of Winding Resistances on Starting Torque of Motor — Methods of Connecting End Rings and Slot Conductors — Troubles That Develop in Winding Connections and How These Are Overcome

BY B. A. BRIGGS

OF THE various types of motors the squirrel-cage induction motor has the most simple and substantial rotating element. The rotor of this type, as shown in Fig. 7, consists of laminated core with semi-closed slots in the outer periphery, in which is placed a bar winding that is short-circuited on two end



Figs. 1 to 6—Showing different types of joints between rotor bars and end rings

rings. The current is induced in this winding by the magnetic field set up by the current in the stator windings, similar to the way the current is induced in the secondary winding of a transformer.

The rotor winding may be made of copper bars connected to copper end rings. In some of the small motors a cast aluminum winding is used. Where it is desired to increase the resistance of the rotor winding so as to obtain a high starting torque, resistance-metal rings may be used, such as iron, brass, monel metal, etc. Instead of a bar winding connected to end rings, short-circuited bar coils are used and these coils may be made of copper, brass or aluminum; in some cases combinations of copper and aluminum coils are used.

The starting torque of an induction motor can be varied over wide ranges by changing the resistance of the rotor winding. Within certain limits the higher the resistance of the rotor's winding the higher the starting torque, with a given stator current. Conversely, the lower the resistance of the rotor winding the lower the starting torque. Unfortunately, high resistance in the rotor winding results in large losses and low efficiency during normal operation of the motor. Where frequent starting and stopping of the motor are required, high efficiency is of secondary consideration and good starting torque is of prime importance. It is in these applications that motors of high rotor resistance may be used to good advantage. In the ordinary general-purpose motor the bars and end rings are made of rolled copper, except in such cases where the end rings

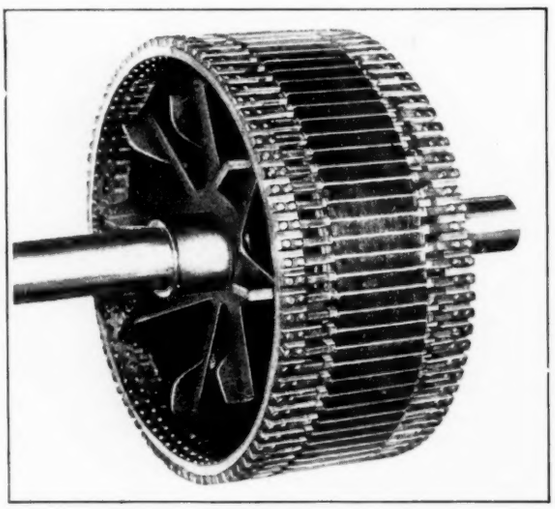


Fig. 7—Rotor on which the bars are riveted to the end rings

are cast on or built up by a welding process. The rings must have sufficient cross-section to provide the necessary mechanical strength and an area that will radiate the heat produced due to operating conditions. Where high-resistance windings are required, if copper were used, they would have to be made so small in cross-section that they would be weak mechanically and heat excessively; for this reason resistance metals are used.

Brass is an alloy of copper and zinc. An end ring made of an alloy of 80 per cent copper and 20 per cent zinc will have a resistance about four times that of a copper ring having the same dimensions. From this

Previous articles appeared in March 9, May 25 and June 15 issues

it can be seen that by using brass of the right proportions of copper and zinc, a wide variation in end-ring resistance may be obtained.

In the construction of the rotor winding there have been about as many different methods used for connecting the rotor bars to the end rings as there have been lines of induction motors designed. In the earlier types it was common practice to bolt the end rings to the bars. In the medium-sized machines one bolt was used, as in Fig. 1; on larger machines two bolts or tap screws were used, as in Fig. 2. Where bolts were used, the ends of the bars were bored and countersunk so that the heads of the bolts would sit down flush with the top of the bar. To prevent the bolts from working loose, a lock washer was placed under the nuts or under the heads of the tap screws when these were used. No matter how tightly these joints were made, they gave more or less trouble by working loose and developing high resistance, even when the connections were soldered after the bolt had been tightened. This was particularly true of motors that were subjected to hard service.

The bars and end rings being made of copper or brass and the bolts of iron, they have a different coefficient of expansion and contraction, the temperature coefficient for copper being about 1.4 times that for iron. Where the end rings have been very hot, the bolts have become so tight as to deform the ring and bar permanently, so that when the motor cooled off the connections would be loose. Such connections heated excessively, and oxidized, and soon the resistance of the

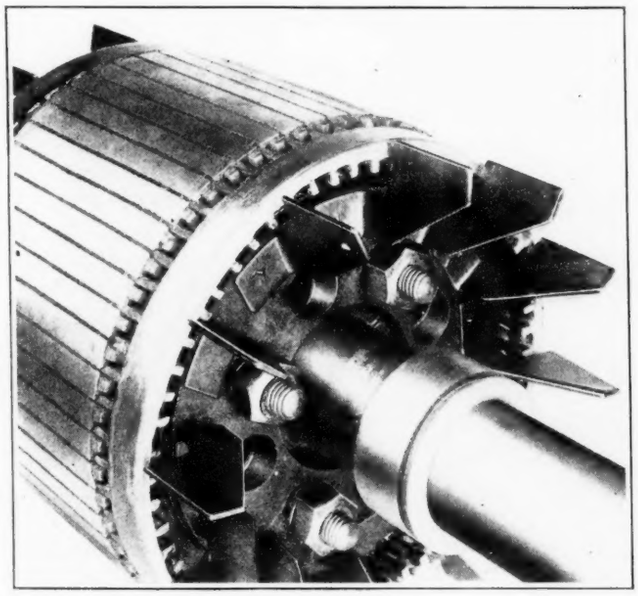


Fig. 8—Flat end rings brazed to rotor bars

joint became so high that the heating was sufficient in some cases to burn off the ends of the bars.

Where soldered connections were used, overloading of the motor might increase the temperature of the rotor winding to where the solder would melt and take the temper out of the spring washers, with the resultant loose or high-resistance connections between the end rings and bars. Such conditions caused unequal distribution of the current in the rotor winding, reduced starting torque, caused noisy operation, and other bad effects.

The end rings are usually of rolled copper, but cast copper rings were also used. One type of such construction is shown in Fig. 3. In this case lugs are cast on the end ring for bolting it to the bars. Ventilating fan blades were also cast on the end rings, to circulate the air through the motor's windings.

In the rotor, Fig. 2, for a large-sized Allis-Chalmers motor, the core is built up of steel laminations mounted on a cast-iron spider, the arms of which are shaped as fan blades to force ventilating air through the motor.

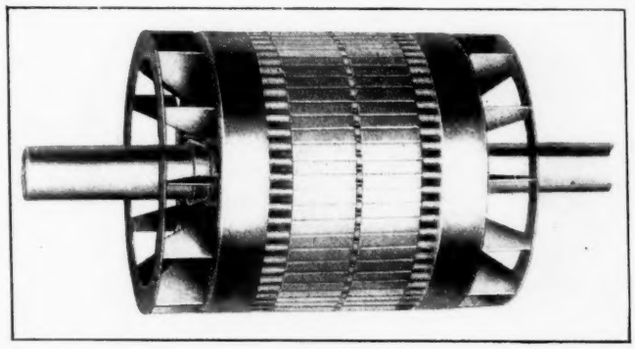


Fig. 9—Channel-shaped end rings brazed to rotor bars

The rotor winding consists of rectangular copper bars, fastened to rectangular end rings by copper rivets, each end of the bar being held to the end ring with two rivets. These rivets are expanded to fill completely the holes in the bars and end rings, and the riveting is done while the bars and end rings are held under heavy pressure. To further insure that the joints will remain tight and not deteriorate mechanically or electrically, they are brazed with silver solder. The bars, end rings and rivets being made of the same material, they expand and contract alike and there is little danger of their working loose due to temperature changes.

In the rotors of the earlier types of motors the bars were insulated in the rotor slots. This insulation consisted of sheet fiber either placed in the slots or glued around the bars. Excessive heating or vibration of the winding due to the operation of the machine frequently caused the windings to work loose in the slots. This caused noisy operation and also increased the tendency for the connections to work loose between the bars and end rings, and in some cases allowed the windings to shift endwise in the slots. In some designs spacers were bolted between the rings and core to prevent shifting of the windings, as in Fig. 6, but this did not keep the winding tight in the slots or prevent noisy operation.

It was found that the destruction of the slot insulation did not materially affect the operation of the machine. This is readily understood when the low voltage generated in the bars and the difference in the resistance of the iron core and the copper bars are considered. Where the rotor bars had their insulation destroyed in the slots, it was not uncommon to see sparks fly out of the slots due to the bars vibrating and making and breaking contact with the iron core during starting. This was also likely to make the motor noisy when starting.

Since the motor operated satisfactorily with the slot insulation destroyed, the most logical thing to do was to leave the insulation out and make the bars of a size to fill the slots completely. This is the practice followed in most all modern squirrel-cage motors. In fact, the practice of brazing, welding or casting the end rings to

the bars made it almost imperative that the insulation be left out of the slots. End rings put on by these methods made it almost impossible to dismantle the winding without destroying it, if it was necessary to renew the insulation. Some of the processes of putting on the end rings increased the temperature of the winding to a point where almost any ordinary insulation would be destroyed. Leaving out the insulation does permit a certain amount of leakage current to flow from the copper to the iron, but, as previously pointed out, this is not sufficient to alter the operating characteristics of the motor to any appreciable extent.

On the rotor winding in the Wagner Electric Corp. squirrel-cage motors the ends of the bars are offset to receive the ring on the outside of the bars, as indicated in Fig. 5, with Fig. 8 showing one end of the complete rotor. The bars in this construction are brazed to the end rings. This brazing process is somewhat similar to

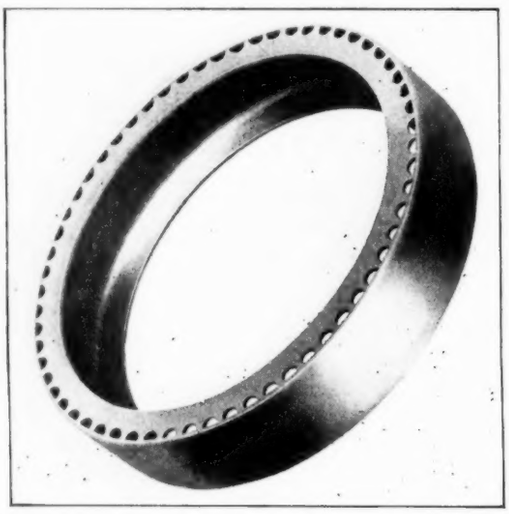


Fig. 10—One of the end rings used on the rotor Fig. 9

soldering, only it is done at a red heat.[1] The material used for the brazing is brass, usually consisting of 50 per cent copper and 50 per cent zinc. The percentage of each metal in the brazing material determines, to a large extent, what the brazing temperature shall be. For example, brass with 20 per cent zinc melts at a temperature of 1,000 deg. C., and with 50 per cent zinc the melting temperature is 875 deg. The lowest melting temperature is found to be 350 deg. C. with a mixture of 80 per cent zinc and 20 per cent copper. Pure zinc has a melting point of 425 deg. and copper 1,075 deg. Using a 50-50 brass gives a brazing material with a melting point well below that of copper and brass containing to 20 per cent zinc.

On the rotor, Fig. 8, the fan blades for circulating the ventilating air through the winding are spot welded to the steel end plates between which the core laminations are held.

A round copper bar is used in the slots of the rotor of the Century Electric Co.'s motor; the complete rotor is shown in Fig. 9. These bars are made semi-circular in form at the end and extend through holes of the same shape in heavy copper channel-section end rings, Fig. 10. The ends of the bars, which extend all the way across the inner surface of the channel, Fig. 6, are brazed to the rings at a high temperature. This joint is brazed with a material that will stand a far higher temperature than the stator winding. The ventilating fans are made up separately and are held to the rotor and plates with machine screws and lock washers. As indicated in Fig. 9, a space is provided

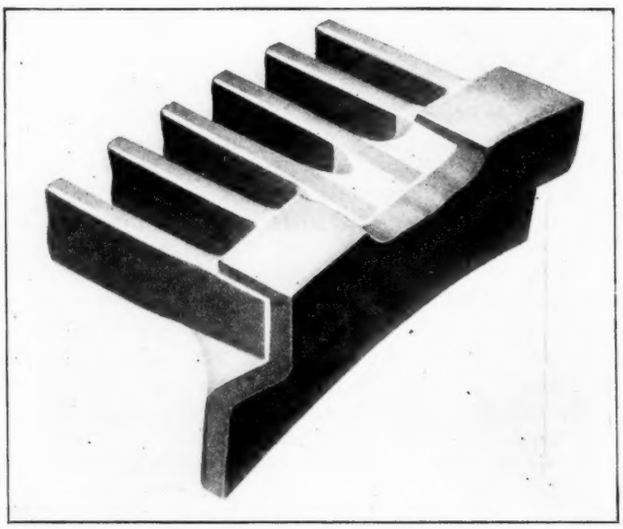


Fig. 11—Section of end ring and bars used on the rotor Fig. 12

between the end rings and the rotor core for the free circulation of air.

A section of an end ring from a Westinghouse motor is shown in Fig. 11 and the complete rotor in Fig. 12. In this construction copper bars are driven into the rotor slots, after which the whole rotor is placed in a specially designed furnace where the bars and end rings are brazed together at a temperature that insures a good mechanical and electrical connection. The core is

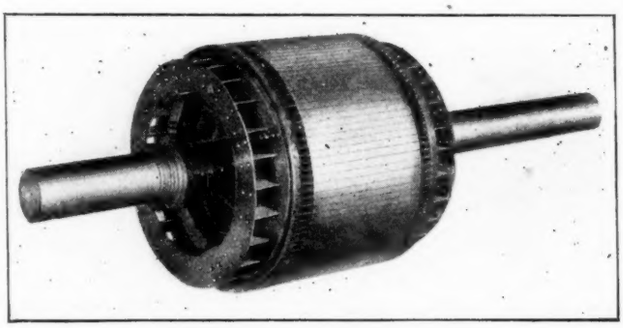


Fig. 12—Rotor has end rings brazed to the bars as indicated in Fig. 11

keyed and pressed on the shaft after brazing, and the outside of the core is machined to insure accurate centering in the stator bore. As shown in Fig. 11, the end rings are made of comparatively thin section and pressed to form a trough for the ends of the bars and the brazing metal. The end rings are held to the core with bolts, and the brazing is done with the rotor in a vertical position. When one end ring has been brazed and cooled sufficiently to harden the brazing metal, the rotor is turned upside down and the other ring brazed to the bars.

A future article will deal with rotors having cast-on and welded end rings.

[1] Lecture, "Mechanical Design of Electrical Parts for Induction Motors," given at Washington University, St. Louis, Mo., by Hans Weichsel.

*Boiler Feed-Water Purification—VIII**

Boiler Compounds

Nature and History—Indiscriminate Dosing Condemned—Classification of Boiler Compounds—Fields of Application—Relative Cost of Treatments

By SHEPPARD T. POWELL
Consulting Chemical Engineer, Baltimore, Md.

INTERNAL treatment of boiler water is the earliest and the most extensive method employed for correcting feed-water troubles. The variety and composition of the substances employed for this purpose is very great. Many of these materials have little or no effect in retarding scale or corrosion or in preventing the

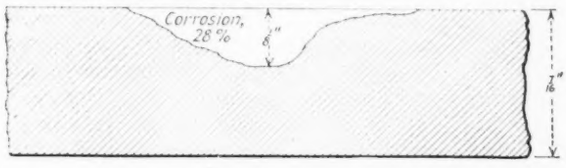


Fig. 1—Section of boiler plate cut away by a corrosive boiler compound

priming and foaming qualities of water. Others have actually caused damage to boilers, while there is a third class of compounds, prepared by reputable manufacturers, that possess merit and have a particular sphere of usefulness.

The use of chemicals and inert substances as a palliative for scale formation and other difficulties encountered in boiler operation, is an interesting subject with a long history. The natural sequence of events early resulted in the treatment of water within the boiler to correct bad feed water and insure better efficiency from the equipment. The materials used were varied to meet the individual notions of the engineer. In some instances the experience gained by the engineer in actual practice resulted in fairly satisfactory treatment, in the absence of exact chemical knowledge of the substances used, but frequently the treatment did more harm than good. The use of dead animals, vegetables (particularly potatoes), potash, soda, etc., indicated the desire on the part of the early engineers to correct bad feed water. There are still many who believe that all boiler difficluties due to feed water may be eliminated by the use of chemical compounds. The majority of these substances, as will be shown later, are sodium salts alone or combined with a small amount of tannin. They usually contain much water.

The indiscriminate dosing of feed water with chemical cannot be too strongly condemned. As a general axiom, the writer believes it is preferable to remove all soluble or suspended solids from feed water prior to use in the boilers. Where this procedure is not economically possible, it is desirable to remove as much of the solid material as possible outside of the boiler. It should be borne in mind that the treatment of water within boilers does not eliminate the ingredients in the water. This treatment merely so changes the constituents as to prevent the scale-forming, foaming or corrosive tendency of the water; the solids in the boiler water must be removed by blowing down.

While the very high pressures and temperatures at which boilers are being operated in large stations, preclude the use of internal treatment in many instances, some relatively large boiler installations are employing internal treatment successfully. These plants are under the supervision of trained operators, however, and the chemicals used are varied with changing conditions of the water and in the operation of the plant.

Many chemists and engineers do not realize that the reactions that take place under high temperatures and pressures may be and no doubt are very different from those at lower temperatures. Since no scientific methods have been developed to determine what these reactions

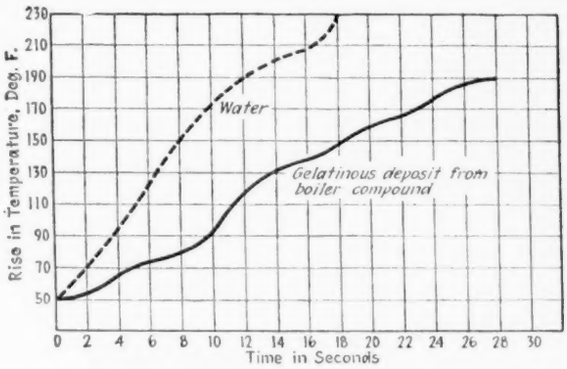


Fig. 2—Showing the heat-insulating properties of gelatinous compounds

are, the use of internal boiler treatment under such conditions is in the twilight zone of scientific knowledge.

Internal treatment of boiler water may be divided into two main classes as follows:

1. Controlling the deposition of scale-forming solids by the use of sodium salts, so as to precipitate calcium and magnesium as sludge which may be blown from the boiler.

2. (a) Adding to the boiler feed water certain chem-

*Previous installments have covered the following subjects: July 6, "Natural Water and Their Impurities"; July 13, "Getting Rid of Impurities by Sedimentation and Coagulation"; July 20, "Filtration by Gravity and Pressure Filters"; July 27, Softening Water by Chemicals"; Aug. 3, "Hot Process Continuous Softeners"; Aug. 10, "Zeolites Explained"; Aug. 17, "Where Zeolites fit in."

ical compounds which prevent the formation of adherent crystalline scale; (b) employment of chemical compounds to prevent corrosion and priming and foaming.

Sodium salts have been used more extensively than other salts to inhibit scale formation and to correct the corrosive properties of water. The object in the use of these salts is to convert the sulphate of calcium and magnesium into sulphate of sodium. When this reaction takes place in boiler water, the calcium and magnesium are precipitated as sludge or mud, in which form they may be removed by blowing down. The sodium

TABLE I—PERCENTAGE COMPOSITION OF BOILER COMPOUNDS CONTAINING PRINCIPALLY SODIUM SALTS

Constituent	A	B	C	D	E	F	G	H
Water	90.37	91.15	91.12	10.65	55.44	7.82	13.56	30.12
Soda ash	7.05	2.65	7.14	48.83	....	15.90	.....	50.21
Caustic soda	....	4.80	....	1.85	....	....	.....	....
Tri-sodium phosphate	....	....	....	....	....	....	.....	1.47
Sodium silicate	....	....	....	....	43.54	....	.....	16.69
Sodium fluoride	....	....	....	....	....	....	81.30	.....
Sodium chloride	0.47	0.35	....	38.14	0.12	74.76	3.62	.....
Sodium sulphate	....	....	....	....	....	....	.....	.....
Potassium chromate	....	0.90	....	....	....	....	.....	.....
Organic matter and undetermined constituents	2.11	0.15	1.74	0.53	0.90	1.52	1.52	1.51

sulphate formed is highly soluble and therefore does not deposit unless its concentration becomes very great. By proper adjustment and control of the application of the sodium salt, the scale formation may be inhibited and the scale formed may be relatively softer than that which would develop without the treatment of the sodium compounds. Sodium hydroxide (caustic soda), sodium silicate (water glass), sodium phosphate and other sodium salts, are used extensively for this purpose.

The scientific studies of Dr. R. E. Hall, late of the Bureau of Mines, has focused attention on this form of treatment of boiler water. In his early experiments he indicated that adherent scale formation could be inhibited by maintaining a proper ratio of the carbonate to sulphate radical. Later, studies by the same investigator demonstrated the fact that under the influence of high temperatures and pressures the sodium carbonate was converted into caustic soda so rapidly that it was necessary to employ other sodium salts to insure the conversion of sulphate of calcium and magnesium into the relatively soft deposits. The success of this treatment depends upon the proper proportioning of the chemical used and the efficient blowing down of the boiler. Failure to fulfill these conditions will result in relatively heavy scale formation and increased tendency of the water to foam on account of the excessive amount of suspended solids.

How Boiler Compounds Are Classified

Boiler compounds offered for sale under various trade names, may be classified usually under one of the following groups: (a) sodium compounds; (b) sodium compound mixed with organic substances, usually some form of tannin; (c) organic substances without tannin; (d) barium compounds and compounds containing castor oil (anti-foaming); (e) mechanical acting compounds; (f) inert materials.

The bulk of the boiler compounds fall within the first two groups. In Tables I and II are reported the analyses of a number of compounds. Many of these consist of a aqueous solution of soda ash, caustic soda, etc., or contain a small percentage of tannin or similar organic matter. From these results it will be noted that the water present in the product ran as high as 91 per cent.

Another class of compounds is known as "colloidal." These preparations consist of inert organic substances that are supposed to prevent the formation of dense adherent scale, depositing sludge which may be blown from the boiler as desired. The functioning of these compounds is based on established scientific facts, but in many instances the desired phenomenon fails to function in accordance with the claims.

The physical chemist has demonstrated the fact that small amounts of certain substances added to salts in solution prevent the coagulation or crystallization of some salts. For example, gelatin, gum arabic, dextrin, soap and many other materials will peptize, that is, they will prevent the agglomeration and precipitation of many finely divided solids. Compounds containing tannin have this effect, as do many other organic substances. A fairly large number of boiler compounds based on these principles have been advanced as a complete panacea for all feed-water difficulties. The use of tannin and dextrin and other organic substances including certain forms of seaweed and marine algæ, is not a new discovery. Carefully controlled, some good may result from this treatment. If not controlled, damage to the boiler from corrosion or burned tubes or crown sheets may result.

Much has been written concerning the merits and demerits of graphite as a preventive of boiler scale. Claims have been advanced for this substance for removal of old scale and prevention of scale formation. Graphite may remove scale under some conditions, but reliable information indicates that it may be a highly corrosive agent when used in steam boilers. The following statement concerning the use of graphite was taken from an article that appeared in the *Journal* of the American Society of Naval Engineers in 1911: "Graphite is a scale remover for the same reason that hydrochloric acid is. That is, it corrodes the metal underneath the scale and frees the scale from metallic surfaces." Possibly graphite has been used more extensively for loosening old scale than for any other purpose. Opinions as to the efficiency of this method

TABLE II—PERCENTAGE COMPOSITION OF BOILER COMPOUNDS CONTAINING SODIUM SALTS WITH LARGE AMOUNTS OF ORGANIC SUBSTANCES

Constituent	H	I	J	K	L	M
Water	30.0	37.79	35.15	90.63	20.60	21.97
Soda ash	....	40.45	34.16	.....	44.24	40.40
Caustic soda	....	.....	3.60	.....	.....	.....
Tri-sodium phosphate	10.0	.....	3.55	.....	.....	3.90
Sodium silicate	10.0	.....	18.33	.....	.....	20.80
Sodium sulphate	....	.....	.....	.....	.....	.....
Tannin extracts	....	17.45	.....	.....	23.54	.....
Other organic matter†	50.0	.....	5.21	5.69	.....	.....
Insoluble matter	....	4.31	.....	3.68	.....	.....
Graphite	....	.....	.....	.....	11.62	12.93

† Other than tannin extract.

vary greatly. By some engineers it is condemned severely. There are others who are very enthusiastic as to its merits. It is the practice frequently to mix graphite with light oil, kerosene oil being employed sometimes for this purpose. When graphite is entrained by scale-forming solids, it bakes on the tubes, forming a high heat resisting material, which may result in burned tubes or bagged sheets. The writer has examined a few boilers where this condition has developed, when only a moderate amount of graphite had been used. The treatment of boiler water by this substance is a questionable procedure in most instances and should never be attempted except upon the advice of an expert.

A class of boiler compound—namely, antifoaming substances—has a special sphere of usefulness. Many nat-

ural waters contain relatively large amounts of sodium and potassium salts. Since these salts are highly soluble and since they increase the priming and foaming tendencies of boiler water, especially in the presence of suspended matter, chemical treatment is necessary to correct these difficulties.

Antifoaming Compounds

An extensive trade has developed for these compounds, especially in railroad practice, where it is often necessary to use water containing a large amount of these soluble alkaline salts. Certain organic acids and castor oil have a marked inhibiting effect on foaming of water. Castor oil, because of this property, is used extensively in antifoaming compounds. No other substances of equal effectiveness have been discovered. Castor oil alone or in combination with organic substances should be used with care, since the amount required varies over wide limits, depending upon the substances in the water.

The foaming tendencies of some waters are difficult to control permanently, owing to the fact that the soluble salts responsible for this phenomenon concentrate at a rate greater than can be corrected by the antifoaming treatment. Foaming in these instances may be retarded sufficiently to permit the use of such water by changing the water at frequent intervals.

Barium salts are used at times as antifoaming compounds. These substances are of service, where, in addition to non-carbonate hardness (sulphate) the water under treatment contains relatively large amounts of sodium salts. By the use of barium the sulphate may be precipitated without increasing the sodium concentration of the water, which would result if soda ash or caustic were used. Before applying antifoaming compounds to boiler water, it is advisable to investigate thoroughly the operating conditions and to determine the true cause of the difficulty. A number of factors influence the priming and foaming of boiler water. Some of these are not affected by the use of antifoaming compounds.

Cost of Treatment

The cost of boiler compounds may or may not be less than that of operating a water-softening system. This depends, of course, upon the price paid for the compound, the amount used and the efficiency of the treatment. Considered broadly and without bias, there are some compounds now on the market that are fraudulent. There are others containing soda and tannin for which the consumer pays an excessive price, based on the cost of the material in the open market.

There are cases, however, where internal treatment has produced good results. The users of boiler compounds should investigate carefully the product and the reliability of the manufacturer before using such treatment. There are a few reputable concerns whose product when wisely and carefully used, may improve operating conditions. In most cases, where boiler compounds are used to advantage, the treatment is applied by intelligent operators and controlled by analyses of the raw and the treated water. It is desirable to remove as much as possible of the scale-forming ingredients outside of the boiler. Where priming and foaming difficulties may not be controlled by external treatment or by proper operation of the boilers, the use of antifoaming compounds may be desirable.

The Hydrostatic Test*

It is of course necessary to test pipe lines and pressure vessels for tightness and strength after they are completed. Furthermore, it is customary to use a considerably higher pressure for testing than the one regularly used in service, in order to show up any defects that may exist and to make sure that the service pressure may be used without failure of any kind.

All building codes and standard specifications for such equipment require the "hydrostatic" test, meaning that the test is made by water at rest. The reasons for using water are three: First, it does not need a large pump, as water can be compressed but slightly; second, if a break should occur, there is not much reaction or "kick" from the slight expansion occurring when the pressure is suddenly released; and third, high pressures can be obtained by it more easily than in any other way.

Water is so slightly compressible that at the depth of a mile a cubic foot of it weighs only half a pound more than at the surface. At this depth the pressure is 2,270 lb. per sq.in. From these data it may be figured that water decreases in volume only about three ten-thousandths of one per cent per pound pressure. Consequently at 250 lb. test pressure (which is not at all unusual) the volume of water would be reduced less than one-thirteenth of one per cent. Therefore when a break occurs, the expansion due to the release of pressure is small and the distortion of the vessel being tested is slight.

On the other hand, using air for testing is a dangerous proceeding because it is highly compressible. One cubic foot at atmospheric pressure will occupy only about one-seventeenth of a cubic foot at 250 lb. abs., so that if a break occurs, the air in the container would expand to 1,700 per cent of its volume, or over 22,000 times what water would, and the blast would probably cause serious damage if not personal injury. In fact a number of fatal accidents have occurred when air was used for testing a defective vessel, so it should never be employed until the hydrostatic test has previously shown the vessel to be safe.

The equipment necessary for the hydrostatic test is very simple, consisting of a small pump, a pressure gage and the necessary pipe connections. One of these connections should be in the top of the system, so all air can be removed from the vessel and connections. This is evidently necessary for safety.

Suitable pumps small enough to be easily carried in one hand, are made by several manufacturers and sell at moderate prices. They are largely used by boiler inspectors in their routine work of testing boilers. When such a convenient and cheap device is available, it is certainly foolish to use air pressure.

The Compressed Air Society makes the following recommendations for installing air compressors: Provide plenty of light and ample room all around the compressor for cleaning and inspection. In foundries, woodworking plants, etc., where there is excessive dust, locate the air compressor in the main engine room and where this is not possible, in a dust-tight room with provision made for drawing clean air from the outside to the compressor intake. The compressor foundation should be substantially and solidly supported.

*Slightly abridged from article appearing in August issue of *Oxy-Acetylene Tips*.

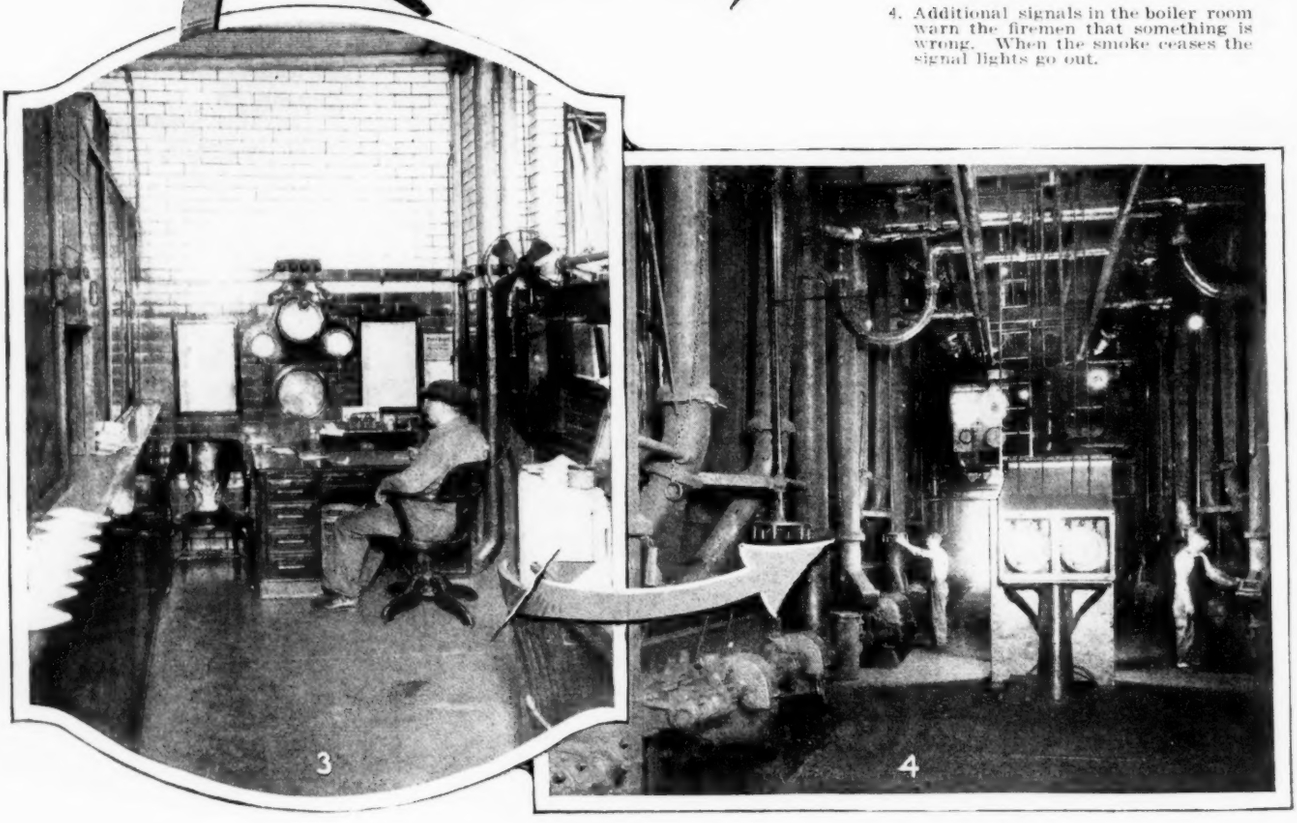
No Smoking Allowed Here

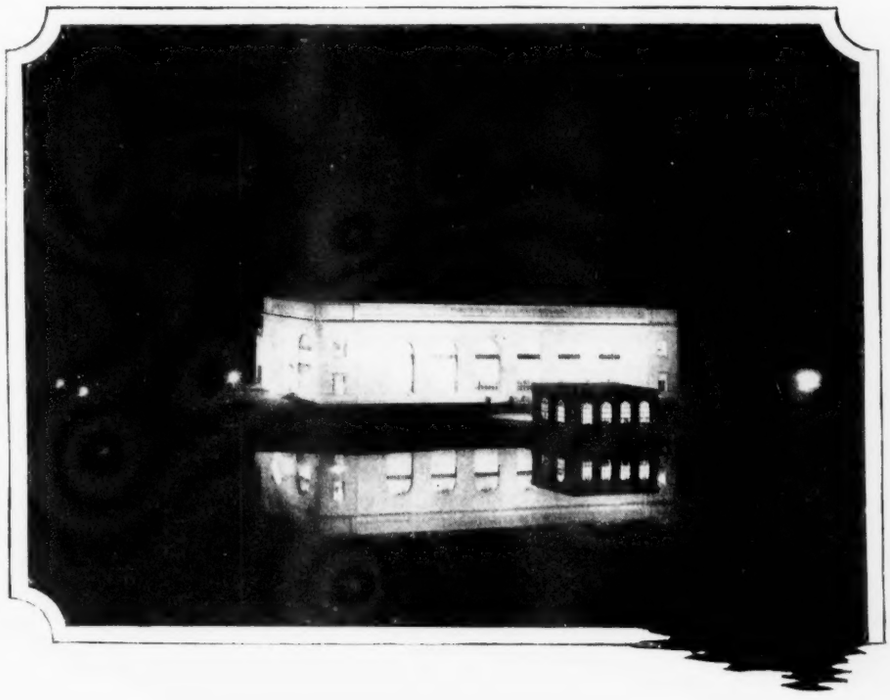
1. A wisp of smoke starts to rise from one of the Waterside (New York Edison) stacks.

2. Patrick Buckley, "Stack Observer," seated in his watch tower on top the 41st Street service building, sees the smoke and throws the proper signal switch.

3. William Dunn, Boiler Chief of Waterside No. 2 (assuming the smoke comes from No. 2) sees one of four signal lamps light up, indicating which group of boilers is offending.

4. Additional signals in the boiler room warn the firemen that something is wrong. When the smoke ceases the signal lights go out.

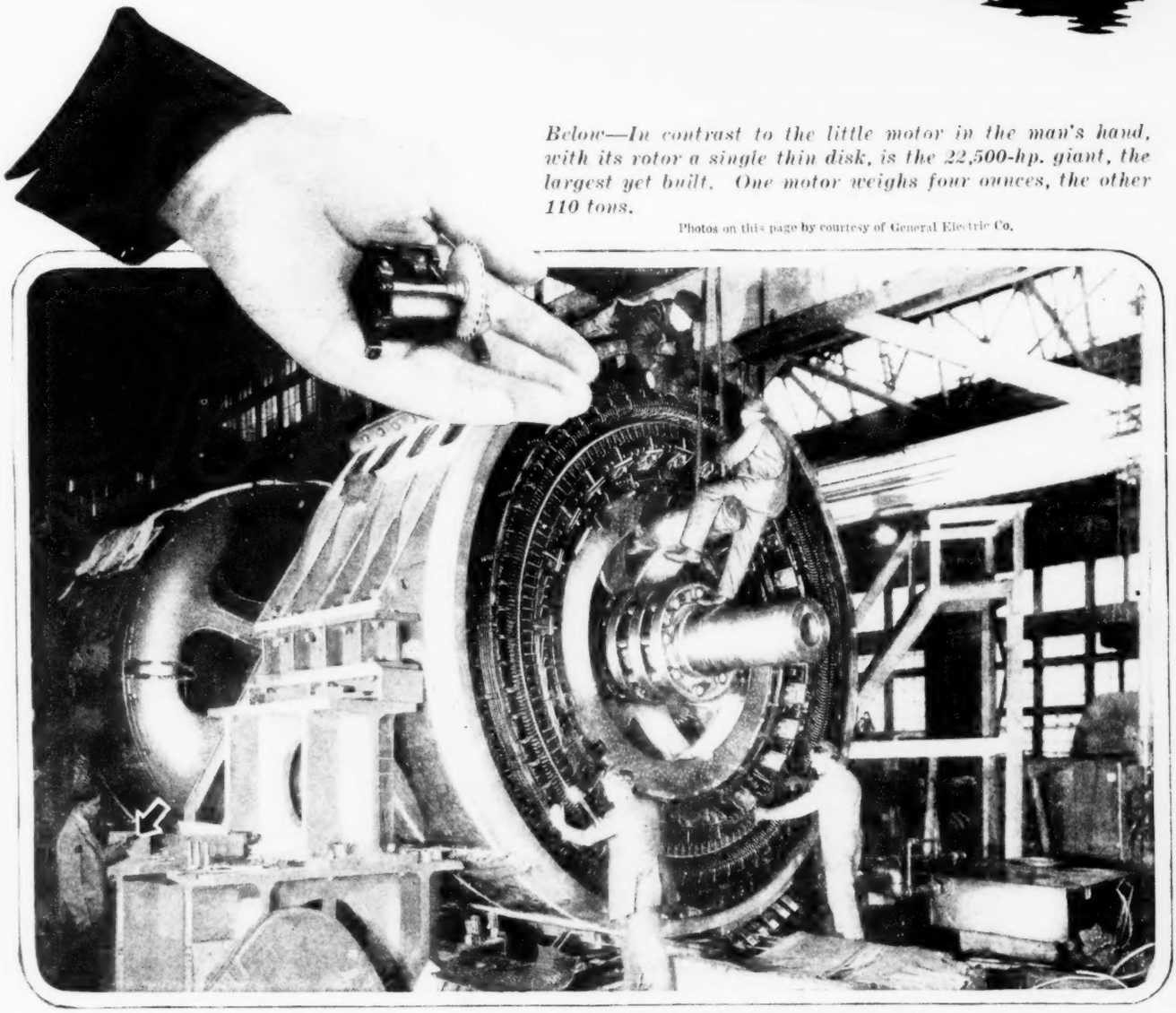




Right — Illuminated by flood lights, and mirrored on the smooth surface of the Mohawk River, the Amsterdam (N. Y.) steam-electric station of the Adirondack Power & Light Corporation is an object of beauty. The present installed capacity of this well-known station is 60,000 kw.

Below—In contrast to the little motor in the man's hand, with its rotor a single thin disk, is the 22,500-hp. giant, the largest yet built. One motor weighs four ounces, the other 110 tons.

Photos on this page by courtesy of General Electric Co.



Equipment for Crushing Coal

By W. W. SAYERS
Chief engineer, Link-Belt Company, Chicago.

CONSTRUCTION and limitations of the various types of coal crusher in use with passing mention of apron conveyors and reciprocating feeders. This is the final of a series of five articles on coal handling. The first, entitled "Modern Methods in Coal and Ash Handling," appeared in the July 27 issue, the second, on "Elevators and Conveyors for Coal Handling," in the August 3 issue, the third, on "Belt Conveyors and Skip Hoists," in the August 10 issue, and the fourth, "Bucket Conveyors and Storage Equipment," in the August 17 issue.

APRON conveyors are used for withdrawing the coal from track hoppers to crushers or to other conveying or elevating units. They are usually equipped with skirt boards or sides to provide large wide openings, suitable for withdrawing run-of-mine as well as small sizes of coal from the receiving track hoppers. These conveyors are constructed of heavy, overlapping steel pans, carried between two strands

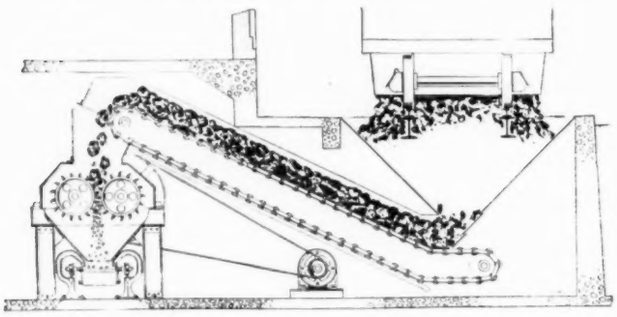


Fig. 1—Apron conveyor transferring coal from track hopper to crusher

of steel chain, fitted with carrying rollers, and may be installed either horizontally or at inclines up to 26 deg. Owing to their substantial construction, the pans will withstand the shock of dumping heavy masses of coal upon them. As they operate at slow speeds, usually from 20 to 100 ft. per min., the maintenance cost is slight. These conveyors also are frequently used for handling ash, for which purpose they are well suited as they carry their load. A typical coal installation is shown in Fig. 1.

When coal is fed from track hoppers and conveyed horizontally for a distance of from 6 to 8 ft., reciprocating feeders are used for delivery of run-of-mine or small coal to the crusher or to other conveying and elevating mediums. As shown in Fig. 2, the feeder consists of a heavy flat plate, having a reciprocating movement, with deep stationary sides. It is of sufficient width to prevent the large lumps of coal from choking while being fed from the hopper. Where conditions are suitable for its application, it is probably the best type of feeder to use.

As mechanical stokers will burn satisfactorily only small sizes of coal, it is necessary to crush run-of-mine or lumpy coal to 1¼-in. cubes or smaller. For performing the crushing operations crushers of several types are used.

Probably the oldest and most generally used is the two-roll crusher. As Fig. 3 shows, it has two cylindrical rolls, each provided with teeth, suitably spaced for reducing the large lumps to the desired size. One crusher roll is driven by means of a belt-wheel or through gearing, and the second roll by means of long-tooth gears mounted on the flywheel shaft.

These crushers are to be had for any desired capacity from 10 to 300 tons per hour, and the lumps can be reduced from any size to 1¼-in. cubes and smaller, depending upon the requirements. The crushing rolls operate at speeds varying from 60 to 120 r.p.m.

The single-roll crusher has been used for many years to reduce lumps of coal to 1-in. or smaller. These crushers consist of a single cylindrical roll, provided

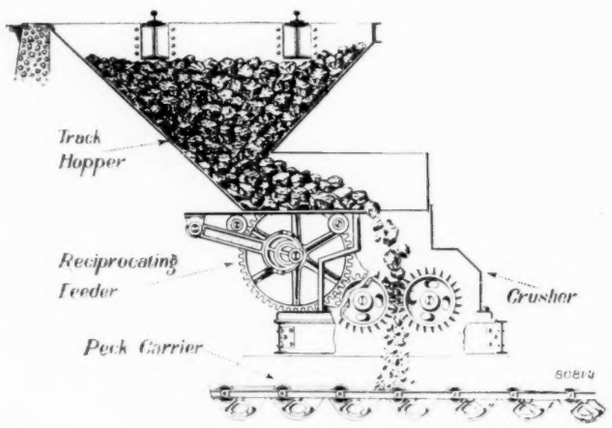


Fig. 2—Reciprocating feeder

with teeth for crushing the coal as it is drawn down between the revolving roll and a fixed crushing plate, as in Fig. 4, which can be adjusted to produce the desired fineness. Single-roll crushers are made in all sizes and capacities up to several hundred tons per hour. The crushing roll usually operates at a speed of approximately 50 to 70 r.p.m.

Where large, lumpy, hard coal is used, the four-roll type of crusher shown in Fig. 5 is sometimes employed. As the name indicates, it is provided with four rolls, arranged so that the two upper, opposite rolls, which are provided with teeth, crush the large lumps to approximately 3- or 4-in. cubes, and the two lower opposite rolls, provided with teeth or corrugations, reduce the remaining lumps to stoker size. These crushers are built in the required capacities and sizes.

The hammer mill, a type of crusher frequently designated as a pulverizer, is coming into more common use

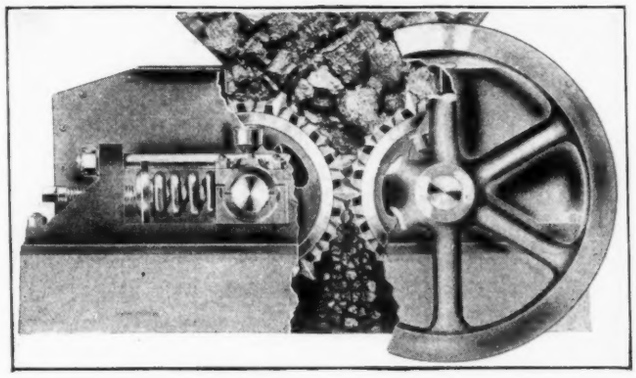


Fig. 3—Two-roll crusher

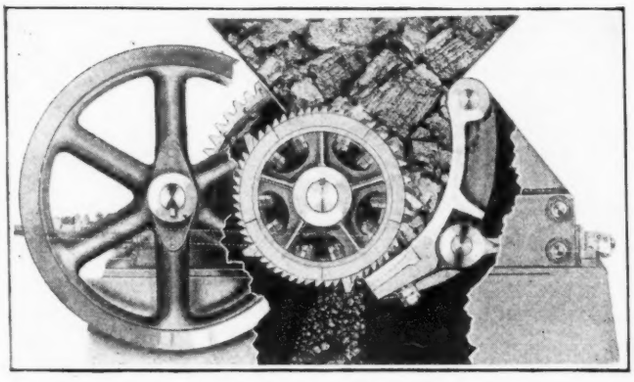


Fig. 4—Single-roll crusher

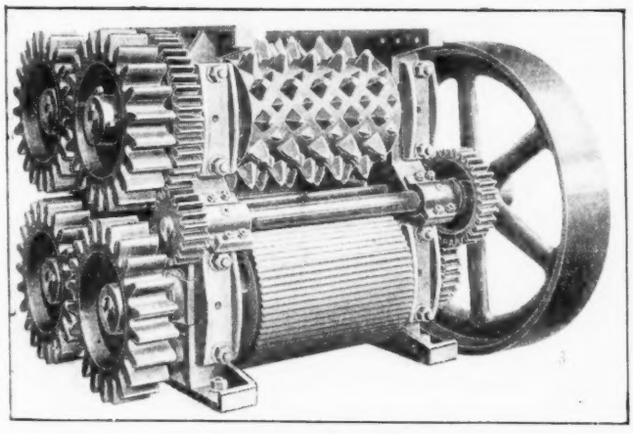


Fig. 5—Four-roll crusher

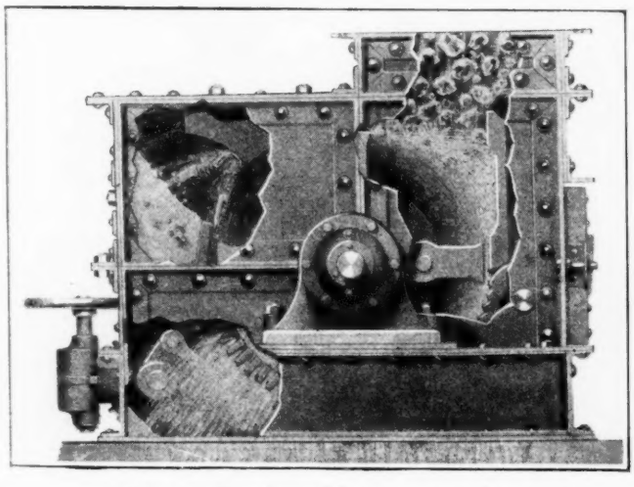


Fig. 6—Section of hammer crusher

in the power house since the advent of powdered fuel and where stokers require the coal to be crushed to cubes smaller than ¾-in. In the sectional view, Fig. 6, it will be seen to have a number of swinging hammers, revolving at high speed, usually 1,000 r.p.m., which strike the lumps and reduce them to a size that will permit them to pass through openings in the bottom of the cage and be discharged to the elevating and conveying mediums. These crushers are built in sizes and capacities to suit requirements.

Another general type is the ring crusher and pulverizer, Fig. 7, in which a series of loose-fitting rings are mounted on each of four horizontal shafts 90 deg. apart, parallel to the mainshaft and supported by cross-arms. The rings are free to move in and out a distance equal to the inner diameter of the ring minus the diameter of the suporting shaft. When the machine is in motion, centrifugal force carries the rings to their

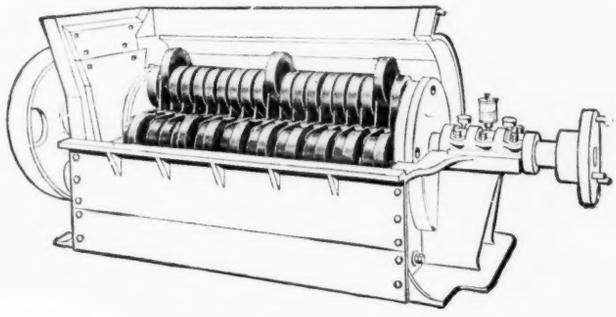


Fig. 7—Ring-type crusher

outer position near to the inside lining of the casing, where they are free to roll and after grinding the coal, force the finer particles through a set of grate bars at the bottom of the casing, which are spaced from ⅛ to 1½ in. according to the fineness desired. Owing to the flexible clearance between the rings and the casing, tramp iron and other foreign material may enter the machine without causing damage. Low power requirements and uniformity of sizing are the claims made for this machine. It is built in capacities up to 500 tons per hour.

For large plants, where run-of-mine or lump coal is to be crushed, the Bradford breaker is well suited and is beginning to be quite generally applied. It is built in sizes from 10 ft. diameter and 12 ft. in length, having capacities of approximately 200 tons per hour, up to 14 ft. diameter and 18 ft. long, with capacities of 400 to 500 tons per hour, depending upon the nature of the coal to be crushed.

As shown in Fig. 8, the breaker consists primarily of a large cylinder provided with round perforations in its shell, of such diameter as to permit the coal to pass through when reduced to the proper size. The inside of the shell is provided with projections against which the lumps fall after being carried up on the inside of the cylinder, thus reducing the lumps to the stoker size. Any foreign matter or substance larger than the diameter of the perforation in the shell is discharged from the end of the cylinder opposite to that into which the coal is fed.

Coal received in ships or railroad cars frequently contains foreign matter, such as coupling pins, coupling knuckles, blocks of wood and other foreign substances that are injurious to the crushers, and for that reason

all types of roll crushers are provided with relief springs, breaking pins or other means for preventing them from being damaged. Nevertheless, the maintenance of the crushing unit is usually the highest of any of the coal- and ash-handling equipment. As it carries the greatest damage hazard, careful consideration should be given to its selection, and wherever possible, these units, excepting the Bradford breaker should be installed in duplicate to insure uninterrupted operation.

After the review in this and the previous articles of the many types of equipment used for handling coal and ashes in the boiler house, it must be apparent to the layman that the selection of the proper machinery for his particular plant is something on which he rightfully should accept the judgment of his own engineer.

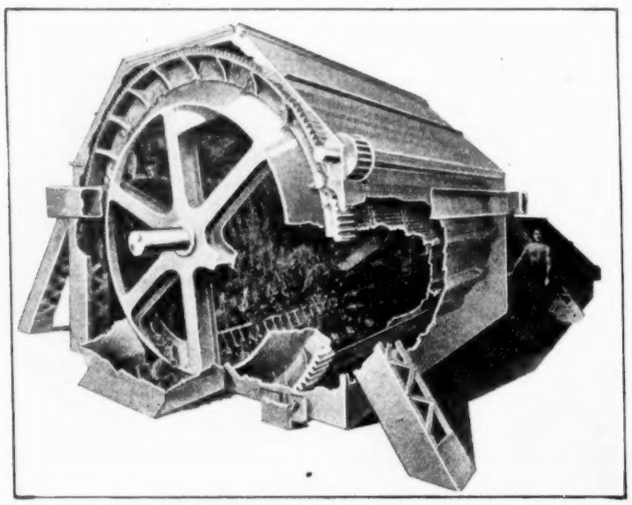


Fig. 8—Bradford breaker

And if his engineer works in close co-operation with the engineers of the manufacturer, who have spent years in building and applying these various units, he will come close to securing good coal- and ash-handling systems for his plant.

No one type of equipment is suitable for handling coal under all conditions. There is no standardized formula for designing machinery for the boiler house. The selection of the equipment varies in almost every case. So much depends upon the size of the plant and the local conditions, that judgment based on experience is, after all, one of the outstanding factors in getting the best equipment to handle economically the coal and the ash.

A CLOUD OF FINE COAL dust may be as dangerous as a body of unconfined gas, if the dust is liberated where fire or heat will ignite it. Great care must be taken to keep every joint in bins, piping, crushing and blowing machinery perfectly tight so that no leakage of powdered coal to air can take place. Hatchways in bins must never be opened while coal is entering the bin nor at any other time except when absolutely necessary and then only under the supervision of the man in charge.—*N. E. L. A. Report.*

AT A TEMPERATURE OF 700 DEG. F. the corresponding saturation pressure of steam is 3,075 lb. per sq.in. abs. For diphenyl oxide this saturation pressure is 100 lb. per sq.in. abs. and for mercury, 19 lb.

Recording Thermometer Used To Check Operations of Steam Traps

BY R. A. TAYLOR*

Traps that leak steam are a source of heat loss in the operation of any power plant. It is not always an easy matter to tell when a trap is leaking steam unless some means are provided to detect the leak. With high-pressure traps it is necessary to make a test to determine the heat discharged, since the presence of steam is no indication that the trap is leaking. If water is discharged from the trap under a pressure of 50 lb. gage, it will have a temperature of about 300 deg. F., and if released to the atmosphere, enough of the water will flash into steam to reduce the temperature below 212 deg., the boiling point of water at atmospheric pressure.

To check the conditions of traps discharging at pressures above atmosphere, the discharge can be run into a known weight of water. The test is started with cold water below the temperature of the air and continued until the temperature of the water is about as much above the air temperature as it was below when the test was started, which will tend to correct the error due to radiation. With the temperatures and weights of water available before and after completing the tests, and the steam-table data, the conditions of the trap can be checked.

For example, assume a trap discharging at 35 lb. gage and the weight of cold water at the start is 30 lb. at a temperature of 55 deg. F., and at the end of the test the weight of the water has increased to 37 lb. and the temperature to 96 deg. The final temperature of two quantities of water when mixed together should be approximately the weighted average of the two temperatures. The initial weight of water was 30 lb. at 55 deg. and the product of the two is $30 \times 55 = 1{,}650$. There was $37 - 30 = 7$ lb. of water discharged at a pressure of 35 lb. gage, which would have a temperature of 281 deg. The product of this weight and temperature is $7 \times 281 = 1{,}967$. Then the final temperature of the total quantity should be $(1{,}650 + 1{,}967) \div 37 = 97$ deg. This would indicate that the trap is tight since the temperature of the condensate, as measured by a thermometer, is less than the theoretical temperature. If the trap is not leaking steam, the temperature of the water at the end of the test should be below the theoretical temperature, as there are some heat losses.

Where the traps discharge water at a temperature below 212 deg., the boiling point at atmospheric pressure, a recording thermometer can be used to good advantage to check their operations. To get a more complete record, a two-pen thermometer can be used, with one pen recording the temperature of the steam going to the process and the other recording the temperature of the return to the hotwell. We have been using a recording thermometer in our plant in this way, and find that it has saved many times its cost. The temperature of the hotwell should, in our case, remain around 130 deg. F., and any permanent increase in the temperature above this is a signal to get busy and determine the cause. These records also have a beneficial effect on the plant operators, since they have a standard to work to and can easily determine at all times if this standard is being maintained.

*Plant engineer, Tayor Instrument Companies, Rochester, N. Y.

The World's Largest Diesel

THE City of Hamburg, Germany, purchases a 15,000-horsepower unit. The engine has nine double-acting cylinders and will be used for stand-by service.

THE installation of Diesel engines for stand-by service has been advocated at various times. Objection, as frequently, has been made that the heavy initial investment in oil engines makes the plan uneconomical. Experience indicates that when coal is the fuel, the banking expense incident to having a steam plant as a stand-by is sometimes great enough to make the installation of Diesel plants entirely justified, especially since there has been a tendency in recent years for the investment costs in a Diesel plant to approach a parity with those of a steam plant.

Just what was the underlying motive that prompted the Hamburg Electrical Works to purchase a 15,000-hp. Diesel generating set is unknown, but probably it was a combination of a desire to install an outstanding machine, a chance to obtain a unit at a price comparable with that of a steam plant, and a feeling that the reduced operating charges made the proposition feasible from an economic point of view.

Experimental 16,000-Hp. Diesel Built Before the War

Blohm & Voss, who hold a M.A.N. license, built an experimental 16,000-hp. Diesel before the War. Results obtained cannot be said to have been commercially satisfactory, but the experience gained evidently enabled the builders to avoid many difficulties with cylinder stresses when the Hamburg engine was developed.

This engine has nine double-acting cylinders 33.86-in. bore with a piston stroke of 59.05 in., and operates on the two-stroke cycle. The cylinder construction is at considerable variance from the typical port scavenging design, inasmuch as the scavenging ports are arranged on a tier between the row of exhaust ports for the top end of the cylinder and the bottom end exhaust port row. At first glance this system might appear to give an inadequate scavenging effect, but experience with other, although smaller, cylinders using this M.A.N. design indicate that satisfactory performance can be obtained.

The liners are held at the outer ends of the cylinders and meet at the inner ends in a zigzag joint, this being provided to accommodate expansion. The cylinder head design eliminates the usual heavy holding-down bolts; instead, a so-called bayonet joint is used. In the circumferential surface of the head are placed a series of lugs which slip down through corresponding flutes in the cylinder-head block casting, and when the head is turned, the lugs lock, light bolts being used to make a water seal at the joint. While this avoids initial distortion due to sledging up bolts, one is rather dismayed by the effort necessary to twist the heavy head to cause the lugs to lock, for the fit must be close.

The crankshaft is in three sections of three cranks each, while a fourth section carries the cranks for the air compressors. The engine cranks are spaced 40 deg. apart.

Considering the size of the machine, the valve gear is by no means complicated. In each of the top cylinder heads is placed a fuel valve set vertically and a horizontally placed relief valve. In the lower head are placed four fuel valves, an air-starting valve and a relief valve,

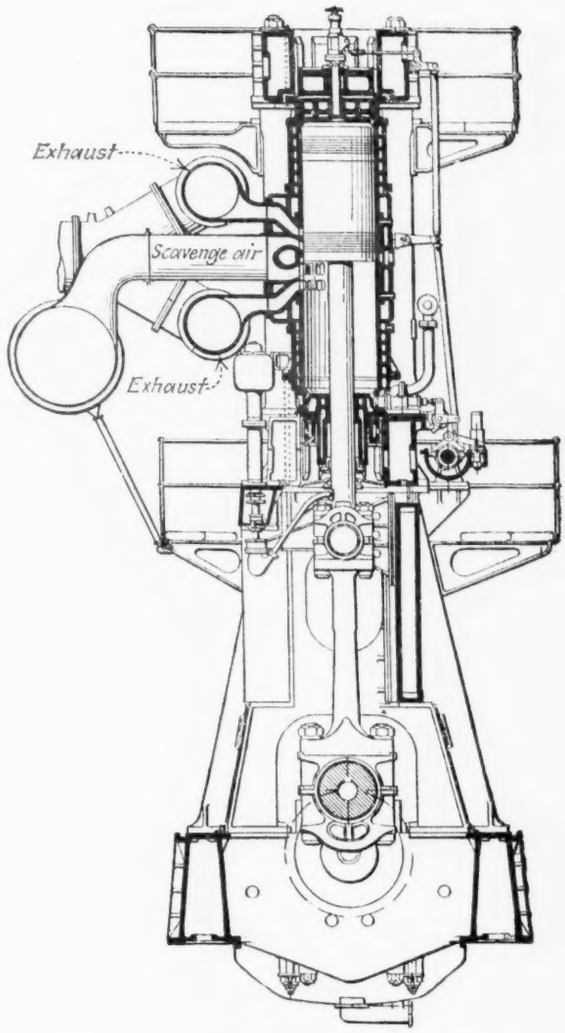


Fig. 1—Cross-section of 15,000-hp. Diesel

all placed in horizontal positions. The nozzles of the lower fuel valves are so placed that the oil sprays do not strike the piston rod, thereby eliminating the chief objection raised against the double-acting principle.

At 94 r.p.m. the normal rating of the engine is 15,000 hp. The engine length is 76.7 ft., and including the generator and exciter it is slightly over 98 ft. The weight of the unit is 233 tons, or slightly over 300 lb. per brake horsepower. This would seem to indicate that the Diesel does not show any substantial reduction in weight at an increase in size.

The starting and injection air is supplied by twin three-stage compressors mounted at one end of the engine frame and driven from the crankshaft. Two motor-driven blowers supply the scavenging air.

The plant building has been designed to accommodate two such units. The air for the scavenging blowers enters through an annex to the building which contains a set of air filters. It then passes through a concrete

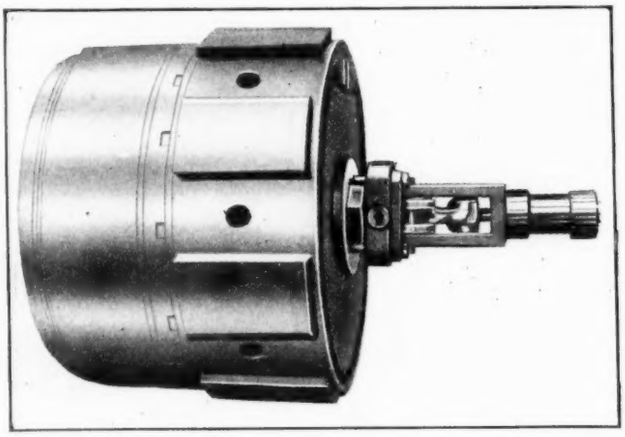


Fig. 2—Cylinder head with bayonet joint

duct to the blowers. The exhaust passes through an exhaust main, there being three such pipes, and flows into pits under the filter house. These pits are built of checkered brickwork and are provided with brick stacks which release the gases above the roof.

Control Automatically Stops Elevator Car Level With Floors

Automatic or self-leveling elevators operate on the principle that inaccurate stops are corrected for by automatically moving the car to the floor level from the point at which it first stops. Should the car stop short of the floor, a switch mounted on the car and controlled by a cam in the hoistway causes the car to move in the same direction to the floor level. Should the car travel beyond the level of the floor, the leveling switch will reverse it and cause it to move back to the floor level.

The automatic-landing system, as developed by the Westinghouse Electric & Manufacturing Co., has been made possible by the adaptation of variable-voltage control to elevator service and operates on the principle of making accurate stops. To make the stop accurately at the floor, it is necessary that stopping begin at exactly the right distance from the floor for each floor and for each stop. To accomplish this, what is called an inductor switch is located on the elevator car. The switch is opened by means of an electromagnet having only part of its magnetic circuit on the car. The remainder of the magnetic circuit, called the inductor, is located in the elevator hoistway and at such a distance from the floor that the car can be stopped accurately level with it. When the operator wishes to stop the elevator, he moves the car switch handle away from the last point and the inductor switch becomes ready to operate, but does not do so until it comes to its inductor in the hoistway. When this point is reached, the car is slowed down and finally comes to rest at the floor level. A mechanical leveling or landing switch causes the car to move the last few inches to the floor level. A return [illegible] switch is not used or necessary because of the ac[illegible] that can be obtained in stopping.

Since accurate stopping within a given fixed dis[illegible]ce is required under all conditions of load in the car, [illegible] important that the electrical equipment be so de[illegible] that its performance is not affected by the load. [illegible]is load in the case of an elevator may be either positive or negative so that the motor must operate from full load as a motor up to about three-fourths load as a generator.

Uniform performance under these conditions can be obtained only with variable-voltage control. With this system an individual generator is furnished for each elevator motor and the motor controlled by controlling the field of this generator. The most important requirements of the generator for the service are the following:

1. A series winding in addition to the shunt winding to correct for the voltage regulation of the generator and the speed regulation of the elevator motor.
2. A demagnetizing winding to neutralize the effects of residual magnetism and insure accurate stops.
3. A shunt winding for controlling the voltage, having a time constant such that if full voltage is applied to it, the generator voltage will build up at a rate corresponding to the desired acceleration of the elevator.
4. Very accurate balancing so that vibrations will not be transmitted to the building.
5. Absence of magnetic noises under rapid changes in load.

Lubrication of CO_2 Compressors

Cylinder temperatures in carbonic anhydride compressors are usually somewhat higher than ammonia compressor temperatures owing to the higher pressures involved.

Mineral oil has no affinity for carbon dioxide, hence there is little or no possibility of its being carried over into the condenser unless it is vaporized, which is not likely to occur when the right oil is used. To insure against any oil whatsoever passing over into the system, an oil trap is usually installed in the discharge line from the compressor. Stuffing boxes are built similar to those on a double-acting ammonia compressor, with the exception that the higher pressures involved require more compartments.

Forced-feed lubrication is the usual means provided for serving the piston rod and maintaining an adequate stuffing-box seal. The same lubricator usually serves the compressor valves and piston as well. The feeding of a suitable amount of lubricant to the stuffing box prevents loss of gas.

The lubricator must be very carefully adjusted at all times, however, the same as for an ammonia machine, since the feeding of an excessive supply of oil will often result in a certain amount of it passing to the gas relief line and thence into the system.—*Lubrication.*

IN THE TAYLOR TYPE of hydraulic air compressor the compressed air is delivered with an oxygen content considerably lower than is normally contained in air. This is due to the absorption by the water. It is not low enough to affect miners who depend upon such air for breathing; nor does it apparently have any effect on lighted candles, matches, etc.

EDITORIALS

F. R. LOW, EDITOR

A Commendable Contribution

ONE has only to read the "Experiences at Cahokia," as related in this issue, to gain some appreciation of the advances in furnace design and practice during the last four years. With one exception a pioneer in the application of pulverized fuel to large central-station use, and faced with the necessity of burning a low-grade Illinois coal, it was to be expected that difficulties would be encountered. Flexibility in the design of the station, however, permitted taking full advantage of progress in the art as applied to the second and third sections and modifications in the first section.

These experiences have contributed much to existing knowledge on the effect of flame impingement upon refractories, the limitation of air-cooled walls and the behavior of water-cooled walls, especially the generation of steam within these tubes at high ratings. But, in view of the fact that most of the large pulverized-coal stations are burning a fairly good grade of coal, the article is especially valuable in showing how to combat certain difficulties incident to the use of a low-grade slagging coal.

Engineering knowledge would be enriched and much useless effort avoided if others would relate their experiences as freely as have the authors of this article.

Chromium in the Power Plant

CHROMIUM is a remarkable metal, strong, extremely hard, somewhat brittle and highly resistant to corrosion. By itself it would be of small use and its high cost would be prohibitive, but as an auxiliary metal it shows great promise.

As an alloying element in steel, chromium has won a place through the wide and growing use of stainless steel for special purposes. But even this material has qualities ill adapted to some jobs where its resistance to corrosion would be of great value.

Recent developments have opened the way to a host of new uses for chromium as a thin coating electroplated on various metals, notably on mild steel. Although chromium plating is laid on to a thickness of less than one ten-thousandth of an inch, it produces a surface with a high polish, resistant to corrosion and so hard that it withstands abrasion to an astonishing degree.

Makers of gages used in checking the dimensions of manufactured parts are studying the use of chromium plated on the faces of such gages, to reduce wear and increase accuracy. An automobile manufacturer is plating this metal on the "bright work" of his product. Headlight reflectors so plated will not stain and cannot be scratched by removing dust and dirt by wiping with a rag.

There must be in the power plant more uses for chromium plating than one can foresee. Wear and corrosion are the enemies of almost everything in the plant. In valves, for instance, a chromium-plated steel stem would resist both corrosion and abrasion in the gland packing. How would plated seats and disks stand up? Will chromium plating resist steam and water cutting as well as it withstands mechanical abrasion? Somebody should try it and find out. What about engine parts? Piston rods, valve rods, valves themselves, and other parts that are hard to lubricate might be given longer life in spite of wear and rust. And governor and valve gear parts of both engines and turbines might be made to give better service if wear could be retarded. Pulverizing and grinding machinery offers a large field for some such protective process; indeed, a start in this direction has already been made by one manufacturer.

Need the list be extended? The idea is clear. Here is a process for accomplishing what the power engineer has long wished earnestly to do. The sooner the maker of equipment makes trial of the results in actual service, the better.

A Big Idea in Education

NO ENGINEERING college pretends for a moment to graduate finished engineers. The professors are in substantial agreement with practicing engineers and captains of industry that the function of the undergraduate technical course is to turn out young men well grounded in the theoretical fundamentals and with enough practical knowledge in one or two subjects (say drafting, testing, or surveying) to get a toe hold in a subordinate position. Practical knowledge is best obtained on the job rather than in the classroom.

Yet even four years of technical school plus many more of practical experience does not necessarily make a good all-around engineer. To attain full competence, the graduate must somehow learn to tie theory and practice together. Each must guide and reinforce the other. Moreover, it must not be forgotten that even the theory an engineer ought to have can by no means be learned in a four-year course. Only the fundamentals can properly be covered in this time. The detailed theory of the engineers' specialties has still to be learned.

Hence continued study of books and other technical literature is as essential to the graduate's progress as to that of the undergraduate. Under present conditions this continuation study is left almost entirely to chance and the initiative of the individual concerned. Neither industry nor the colleges have gone much beyond warning the graduate that education must last as long as life itself. Of definite guidance there is practically none. Why not have continuation courses for college graduates, whereby, without giving up their jobs, they can consolidate and extend their knowledge in the field of their chosen specialties.

This need was recently stressed by W. E. Wickenden, director of the investigation now being carried on by

the Society for the Promotion of Engineering Education. He suggests that the engineering colleges should co-operate in setting up an "adequate system of post-scholastic training, combining business training, specialized technical training and related introductory experience." He further suggests that these elements "be integrated into a true professional novitiate equivalent to the interneship of the physician." An adequate system of this type, tied in with the award of professional degrees and admission to the higher grades of membership in the engineering societies, would call for large scale teamwork by the colleges, the industries and the major professional organizations. The initiative, thinks Mr. Wickenden, should come from the colleges, which have the most direct interest in the success of the graduates. The colleges should provide the nucleus for the necessary organization.

The idea seems to be sound. Conceived and carried out with broad vision and "sold" to the majority of graduates, it should develop and enrich the whole engineering profession and with it, American industry.

Reliability Should Be Given First Consideration

RATING of electric motors is something like the weather, it is always with us. First there was the forty-degree temperature rise machine with an overload rating. This was followed by the fifty-degree motor with no overload rating. The use of fifty-degree motors, under some of the severe conditions in which motors are required to operate, proved to be almost a calamity and brought forth such a barrage of protests from operating men that the motor was removed from the market and a machine with a forty-degree rating adopted, without any overload. This rating seems to have been, in general, satisfactory, but the question of going to a higher temperature rating and the need for overload capacity have remained active issues.

If the load on a motor were a definite and constant quantity, there might be some reason for hairsplitting on ratings. The load on a motor may vary widely owing to the characteristics of the load and also to the maintenance and adjustment of the driven machine and the kind and quality of product made. Then again, the conditions under which the motor operates may vary, being affected by climate, altitude and the temperature and cleanliness of the surrounding air. A motor on the floor of a room, where the air is clean and at normal temperature, is in a much more favored position than one on the ceiling of a room in which the air is at a high temperature and saturated with dust.

Motors operating in clean places will naturally remain cooler under the same load and air temperature conditions than those operating where the air is laden with dust. The dust collecting on the surfaces of the iron and coils not only makes it more difficult to dissipate the heat developed in the windings, but also clogs up the ventilating passages and prevents the free circulation of air.

When a motor can be operated at a load corresponding to its rating, it is more by accident than by any established rules of sound engineering. Even if the exact load requirements are known, standard motor ratings are not available to meet every load exactly. For example, if the load requires eight and one-half horsepower to drive it, there is no standard motor of this rating. To use a standard size, either a seven and a half or a ten-horsepower machine must be applied. If the former is used, it will be operating overloaded, and if the latter is chosen the motor will be underloaded. Therefore, the purchaser has either one of the two choices.

Knowledge of the power requirements to drive various loads is generally not so exact as to allow making motor application without a factor of safety. The number of motors in use that are much underloaded would indicate that the factor of safety has been worked to the limit.

To the average purchaser of motors the question of rating is of little consequence as long as he gets a machine that will drive its rated load and do it without operating at a temperature that will destroy the insulation in a few years. What the motor user wants is reliability, since failures are expensive in repair bills and in loss of production. If reliability can be obtained along with other desirable characteristics, the user is willing to overlook any lack of a hairsplitting rating of the machine.

Why Call It a Diesel?

IN THE early nineties Dr. Rudolf Diesel outlined his rational motor. This, the first Diesel engine, was to operate on the Carnot cycle having an initial isothermal compression followed by adiabatic compression to the maximum temperature of the cycle. Fuel was to be introduced at such a rate as would enable the heat added to just equal the work performed on the moving piston, with the result that the cylinder temperature would remain constant during the combustion period. At the end of this period, adiabatic expansion was to carry the temperature down to that of the atmosphere. This was not a practical machine, and in the first commercial Diesel the entire compression was more or less adiabatic and combustion at constant pressure, air being used as the injection agent.

Examination of present-day oil engines fails to reveal any that in service operates on quite the real Diesel principle.

Probably no single inventor has within his lifetime seen as much publicity given to his patents as did Doctor Diesel, and it has become the custom to apply the term Diesel to all engines having a compression high enough to ignite the fuel. Inasmuch as none actually operates on the Diesel cycle, why would it not be better simply to classify all as oil engines?

At present the purchaser, unless he has gone deeper into the matter than is usual, presumes that all are more or less alike, each being classified as a Diesel by its maker. It has the effect of lulling the buyer to sleep, and he fails to give the individual engine the close scrutiny it deserves.

If, on the other hand, the public, the engineering bodies and the engine builders called these internal-combustion engines of automatic igniting ability simply oil engines, the purchaser would, perforce, be compelled to examine each engine offered to find out how it works. The present-day oil engine is more or less a foundling, and it is an imposition upon Doctor Diesel and upon the public to attempt to prove that the former was even the attending physician.

Those who know anything of the background of the oil engine's history know that Charles Ackroyd Stuart was the real father, and if it is to receive a particular name surely "The Ackroyd" would seem more fitting than "The Diesel."

Practical Ideas From Practical Men

Should the Power for Motor-Driven Auxiliaries Be Taken Off the Line or Load Side of the Totalizing Meter?

There seems to be no clear-cut idea in the minds of a good many engineers regarding the metering of the power used by station auxiliaries such as motor-driven exciters, stokers, forced-draft fans, condenser pumps, etc., and I should like to get an expression from other readers of *Power* regarding this.

When the switchboard is equipped with a totalizing watt-hour meter, I believe that the power for all station auxiliaries should be taken off ahead of this meter, because the totalizing meter should register the true output of the station.

For instance, let us consider a stoker which usually is equipped with a steam engine at one end of the shaft and an electric motor on the other end. When the stoker is being driven by the engine, the energy required to drive it is reflected in the coal consumption, but not in the totalizing watt-hour meter reading. However, when the stoker is being driven by the motor, the energy consumed is reflected both in the coal pile and in the totalizing meter if it is connected on the load side of this meter.

Thus, it is apparent that when the plant auxiliaries are connected on the load side of the totalizing meter, the records obtained are misleading for the reason that only those auxiliaries that are motor-driven are recorded, while those that are steam-driven are not.

In a plant in which all the auxiliaries are steam-driven, the reading of the totalizing watt-hour meter would record only the useful output of the station. In a plant in which part of the auxiliaries are steam-driven and the other part motor-driven, the reading of the totalizing meter has to be interpreted properly in order to have any value.

C. J. SNOW.

St. Paul, Minn.

Correcting Low Power Factor

I once operated a plant consisting of a 500- and a 1,500-kw. turbine, the smaller unit being old and used only as a stand-by, since the load conditions compelled us to run the large machine about 16 hours a day. We were tied in with two hydro plants which had a total capacity of about 2,500 kw. There were many times when the load was light enough for the 500-kw. unit, but on account of low power factor we had to keep the large unit on the line. The power factor averaged 60 per cent, and at a load of 500 kw. the small generator heated up and the voltage dropped so much that complaints came in from numerous sources.

The rating of the small unit was 625 kva. at 80 per cent power factor, and when the load reached 500 kw. the kva. output would go up to 830 or higher and the machine became dangerously hot. The difference in steam consumption of the small unit at full load and the large unit at 500 kw., or one-third load, was large enough to make a difference in operating costs, but the power-factor conditions prevented an economical load distribution between the plants. For four months in the year enough water came down the river to carry 30 per cent more load than the hydro plants were carrying, but for the same reason they could not carry full rated load without having trouble with low voltage and coil heating. So actually there were times when the steam plant ran, and at the same time water was running over the dam going to waste, especially from Saturday morning till Monday morning.

Once as an experiment, when the operator in No. 1 hydro plant informed me that he had 10 in. of water going over the dam with all the waterwheels running at two-thirds load, I allowed the turbine to motor, or in other words be pulled along by the waterwheel. This was done by cutting down on the speed till no load showed on the switchboard and then adjusting the field rheostat till the generator appeared to be developing about 900 kva. This procedure held the voltage up to normal and at the same time loaded the waterwheels to full capacity, but of course could not be kept up indefinitely, so I then tried carrying the smallest load I could on the turbine. I found that the governor did not function well at loads below 250 kw. and too much switchboard attendance was necessary. By throttling the turbine I admitted just enough steam to hold it up to speed, the wattmeter on the tie panel showing no load. When the machine had been motoring, the tie panel wattmeter showed an input from the other plant of 120 kw., the current required to float the machine on the line. Further experimenting showed that 5,000 lb. of steam an hour was required to run the turbine without load, so I reasoned that with excess water available the turbo-generator could function as a synchronous condenser provided enough steam were passed through the turbines to keep the blades cool. To prevent surging of the load and voltage variation, the turbine had formerly been operated at a minimum load of 250 kw., which took about 8,000 lb. of steam per hour.

I then planned a small bypass around the turbine throttle, which would pass approximately 1,000 lb. of steam an hour through the turbine. This idea would be effective only during that part of the year when plenty of water was available, or about 4 to 6 months. The master mechanic agreed to carry out my idea, and after operating through the high-water season without carrying any load with steam-driven equipment, the saving was indisputable. The 5,000-sq.ft. boiler which was necessary to run the steam-driven unit was shut down and a 1,500-sq.ft. unit used in place of it. In the four months the output of the hydro plants increased a million kilowatt-hours over the previous year. The cost of current was figured as ½c. in the hydro stations and at 1½c. in the steam plant, so the saving by reducing the cost of a million kilowatt-hours was around $7,500. The actual coal saving, however, was $6,500, the re-

maining $1,000 representing the wages of the operator who was required in the steam plant in case of emergency and the capital charges on the turbine unit. The turbine was started and paralleled in the usual way, then the bypass was opened and the throttle closed. At any time we could pick up load with the turbine by just opening the throttle. Flashboards were used on the dams, and often the wheels carried an overload of 15 per cent without difficulty owing to the power factor being maintained at 94 per cent. G. H. HART.

Thompsonville, Conn.

The Engineer Thinks It Over

The engineer took his customary walk through the powdered-coal plant at a quarter to seven to be sure that everything was all right. His general glance around showed that everything was in the same clean and orderly condition as it was when he left the plant the night before. He went over to the switchboard to start the various units. The first switch closed was the one that energized the magnetic separator. The pilot light across the magnet immediately showed the current was there. One by one other units were started and in a few minutes the plant was in operation.

Turning from the switchboard, the engineer noticed a short piece of copper wire lying on the floor, it was about No. 10 and approximately an inch long. Instead of leaving it there to be swept up, he picked it up and examined it. He noticed that one end showed a recent cut and the other end was broken off. Furthermore, he knew this bit of wire was not there the night before because he had had the floor swept late in the afternoon. It could not have fallen from above because the coal storage bin was directly overhead and there were no wires there at all. The watchman never crossed the floor at that place and no one could get in as the door was kept locked.

Still, a bit of copper wire could not appear on the floor of its own accord. It must have been brought in by someone, also, that person must have been there during the night or in the early morning. Why anyone should break in the plant to put a piece of copper wire on the floor he could not imagine—perhaps they were up to some mischief and the wire was dropped on the floor by accident. That at least sounded more reasonable. There were, however, no signs of any mischief and everything started up without a single hitch. But the engineer was going to play safe, so he went over every motor and bearing to be sure they were running all right. Everything was fine, but he felt far from satisfied.

After a little more consideration he felt sure that if anything was wrong, it would show up in the electrical equipment somewhere. The question of how anyone could get into the plant who had no key was next thought over. There was only one way and that was by crawling over the crushed coal on the belt conveyor, where it came through the wall. Running up the ladder to the conveyor, the engineer examined it all over. There were plenty of signs of people having been around the conveyor, but then the engineer and the oiler were up there many times every day, so the tracks were probably theirs. But upon looking still more carefully it was evident that someone had been up there since last night and had crawled in through the opening in the wall where the conveyor entered.

The engineer was now really worried and again checked up every piece of machinery, but could find nothing wrong. Nor could he think of anyone who would be inclined to do damage to the powdered-coal plant. He had no enemies so far as he knew.

The yard master happened along about this time and the engineer had a talk with him and, without letting known his suspicions about possible trouble, found out that one of the yard laborers named Harold Jones came to work quite early that morning, that he used to work for the electric power company and was of a radical disposition; in fact, he was causing so much trouble by his arguing with the men that he was going to be discharged on Saturday.

The engineer now had a hunch that this man was probably at the bottom of the mystery, so again he went over everything but could find nothing.

The crushed-coal supply was getting low, so the engineer started up the crusher and as soon as he saw the conveyor running, he went up to see if the rolls were all running properly. He had to pass the pilot light that showed the magnet was in operation, and as was his custom he wiped the lamp with a piece of waste to clean off the coal dust. As he pulled his hand away he noticed that the lamp appeared to flicker. At first he attached no importance to this as he had noticed the same effect many times about the shop—suddenly it dawned upon him that this was noticeable only in lamps lighted by alternating current. The magnet was operated from the direct-current mains. The voltage of the two systems were the same. Something was wrong here without question, and without stopping to investigate any more he ran down the stairs and over to the switchboard where he pulled open the switch for crusher and conveyor. He knew that if through any reason the magnet was on the alternating-current line, it was practically useless because it was designed for direct-current and would not pick up anything on alternating current.

The engineer now carefully followed the line from the switch back to the magnet and found everything O.K., but from the switch to the main he discovered where the line had been cut and spliced over to the entering alternating-current main. It took about fifteen minutes to change the lines back to the direct-current main and upon throwing in the magnet again and testing with a hammer head, he found it O.K.

He was busy for the next halfhour getting a supply of crushed coal ahead. Upon the next trip to the magnet, he found about two handfuls of iron tumbling mill stars on the magnet face. These had evidently been thrown in the coal hopper and had they got past the magnet and into the pulverizers considerable damage would have been done.

Everything now being safe, the engineer called the superintendent and told him about the attempt to wreck the plant. Then they informed the yard master and while telling him about it and their suspicions, walked toward where Harold Jones was working. He, however, must have suspected something, for he dropped the hook rod with which he was hooking up the crane for a lift and ran toward the employees' entrance, past the astonished watchman into the street. He never returned, nor did he send for his back pay and the employment agent could find no trace of him at his boarding house.

The engineer received a substantial increase in his rate and his pals now call him "Sherlock."

Canton, Ohio. GEORGE P. PEARCE.

Comments from Readers

Many Opportunities for Improving the Economy in the Older Power Plants

If a plant manager went into his power plant and told his engineers and firemen that he would give them $1,000 cash bonus for every practical idea submitted that saved $5,000 each year, many first-class ideas for saving would be forthcoming. And if these ideas could be put into practice at moderate first cost, the firm would draw a good rate of interest on the bonus money expended. In any industrial plant built over 15 years ago, countless opportunities exist for the application of this plan.

I recently visited an engineer in charge of a plant that had just had a wreck, due to water in the high-pressure cylinder of a compound engine. The engine had been rebored three times, so that the company decided on a new cylinder. The engineer was ingenious and realized that the plant could be made more economical. The greater part of the load on his boilers was to supply process steam, and he had always felt that exhaust steam should replace live steam. But the engine had been so heavily loaded that condensing operation was necessary, as the cutoff in the high-pressure cylinder was at 40 per cent of the stroke. He had figured the water rate to be 15 lb. per hp.-hr. at 125 lb. initial pressure. The boilers were old and operated under forced draft beyond the economical rating, and his fuel cost of steam was 43c. per 1,000 lb.

His idea, as he outlined it to me was this: As $1,480 was the cost of a new cylinder of the Corliss type and would not improve the economy of the plant any, he wanted a specially designed cylinder for higher pressure and temperature. He planned for a poppet-valve cylinder on the high-pressure side. A plant across the street, with a distance of only 300 ft. between boiler rooms, had boilers operating at 210 lb. pressure and 100 deg. superheat. With the increased pressure on the engine, as much power could be developed non-condensing as was formerly developed running condensing, and the exhaust could be used in process work.

There was a demand for 25,000 lb. of process steam per hour, and at 76 per cent efficiency the engine would show a steam rate of 20 lb. per hp. His load was close to 1,000 hp. and the rebuilt engine would exhaust 20,000 lb. of steam an hour, with no excess; in fact, 5,000 lb. of live steam would be required. The load of 41,000 lb. per hour (16,000 for power and condenser and 25,000 for process), would be reduced to 25,000 lb. The day fireroom crew of four men would be reduced to one man, since only one boiler would be kept in operation to generate 5,000 lb. per hour and act as a reserve unit. The night crew would also be reduced to one man, thereby saving $20 a day in labor costs. The plant functioned at full load 9 hours a day, and at about half-load for 6 hours, which gave a total steam flow equivalent to 12 hours at full load.

The cost of purchasing steam would be 65c. per 1,000 lb., the purchaser paying the cost of a 6-in. steam line between the two plants. These plants being in the country, no obstacles lay in the way of either an overhead line or an underground one. He had estimated the cost of an overhead line as $1,100, the underground construction being more costly. The new cylinder and valve gear would cost $4,200, or $2,720 more than the cylinder the company had planned to purchase. Thus the additional cost of putting his plan into operation was $3,820, but the possible saving was large.

His steam was costing at 43c. for 41,000, $17.63 per hour, and buying 20,000 at 65c. per 1,000 lb. and generating 5,000 lb. at 43c. per 1,000, would cost only $15.15 per hour. The annual fuel saving would be $8,094, and reducing the boiler-room force would save $5,200 in wages. But even a $13,000 saving failed to interest the manager, who made a practice of sidestepping whenever the engineer made any suggestions that called for a cash outlay on the steam plant. Some vague remark about electrifying the mill in a few years was his favorite reply to any plans of the engineer, and the man swore he would never work out any further plans for this particular plant, as he had never been given the slightest encouragement.

Another company has purchased a second-hand compound engine, and this unit together with a simple Corliss generated all the power. The compound engine carried a load of 600 hp. and the Corliss about 350 hp., both run condensing. The estimated water rates were 16 lb. for the compound engine and 20 lb. for the Corliss. Neither of these rates were favorable for economy, as the boiler pressure was only 110 lb. Now the compound engine had been rated at 1,000 hp. in the plant where it had originally been installed, but had operated at 195 lb. initial pressure. Here is the idea that was suggested to the plant owners, who adopted the plan at an outlay of less than $3,000.

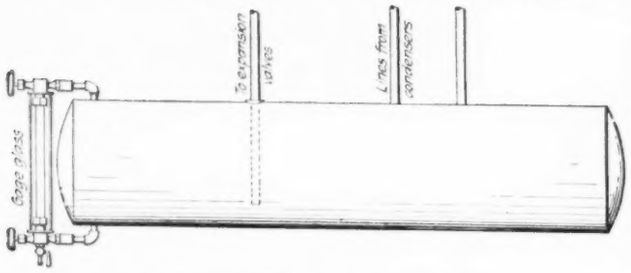
A plant in the same town was discarding about 20 boilers of the vertical fire-tube type in favor of water-tube boilers. Four of these boilers were only 8 years old and the insurance company had allowed 192 lb. pressure at the last inspection, and they were to be taken out only because they were not adapted well for pulverized fuel. They were on the market for $1,000 each, and two of them could supply enough of steam to carry the entire load with the compound engine, thus allowing the Corliss engine to be shut down. With more energy available per pound of steam and greater density at the higher pressure, the compound engine carried 950 hp., with an earlier cutoff in the high-pressure cylinder than formerly, reducing the water rate by 20 per cent. The steam saved by shutting down the Corliss and its condenser pump was about 4,000 lb. per hour. The plant had a day operating schedule of 60 hours a week the year round, and for a few months a night shift was added so that the engine ran about 4,000 hours. A saving of 16,000,000 lb. of steam in a year meant a reduction in operating costs of $6,400, due entirely to the ingenuity of the engineer.

Brightwood, Mass. A. F. SHEEHAN.

What Causes Bubbles in Ammonia Receivers?

On page 1023 of the June 29 issue of *Power*, in answer to the question of what causes bubbles to rise in the gage glass of an ammonia receiver, the statement was made that these bubbles are undoubtedly air that has been trapped with the liquid as it comes down to the condenser and is bubbling up through to the top of the receiver. I believe this an error; you will see by the inclosed sketch that the air would first have to go straight down to the bottom of the lower glass connection through a liquid seal.

I have noticed this bubbling in the glass in the plant here where I am employed, both when we are operating and when we are shut down in winter, and my explanation is that the ammonia in the bottom connection of the glass is colder than the surrounding air, and by picking up this heat the ammonia boils and the resulting gas appears as bubbles in the glass.



Pipe connections at the receiver

Seaside Heights, N. J. ANTHONY J. WOLFF.

Not too Old To Study or Profit by Good Advice

In the June 29, 1926, issue of *Power* (page 1003) the "Chief" tells the young fellows a lot of things about how to get ahead in the power plant. I think the only mistake the Chief made was in not addressing his remarks to the older men as well, for I believe some of us ought to take heed of his advice as well as the younger men.

After reading his remarks, I subjected myself to a self-examination, using his article as a guide. I wasn't any too well satisfied with the results. I had never thought of these things in the way he expressed them and can see where they would have a deterring effect on a man's advancement.

I note in particular his advice regarding the taking of a course in a correspondence school or the purchase of good books on the line of work one wishes to follow. Last fall I bought a set of Tulley's Handbooks, and having Croft's book on boilers, together with the issues of *Power* which an engineer friend passed on to me after he had finished with them, I laid out a course of study for the winter. As I went along I made a set of test questions on each chapter, which I used for self-examination. At the end of June I gave myself a final examination, and being satisfied with the result, I made application for a first-class stationary engineer's license and passed a creditable examination. Prior to this time I had held only a third-class license.

The only advice I can offer to anyone laying out a similar course for himself is this: Whenever you have any doubt regarding your knowledge of any section you have covered, give yourself the worst of it, go back and go through it again. If you just slide over some part, you are harming no one but yourself. As you go along, see where you can apply your new knowledge to your work. And when you do find a place or two where you can apply what you have learned, see what an added interest the course takes on.

The total cost of my "kitchen-table" engineering course was $10.50, as early in the spring I wrote a short item for *Power* which gave me enough to pay for a year's subscription, so that is not charged to the course.

But, as the Chief says, having gotten into the habit of study, it is difficult to let go, and so I next expect to lay out for myself a more advanced course in "kitchen-table" engineering.

I regret that earlier in life I was not able to serve an apprenticeship under an engineer such as the Chief, from his writings, appears to be. Even now, if I lived in his locality, I am afraid I would be applying at his office so often that in self-defense he would have to find a place for me in his organization. The youngsters who are able to start their experience under such a man do not know how fortunate they are. They should make the most of their opportunities.

Wise River, Mont. F. W. GOLDSMITH.

Effect of the College on Engineering

I read with interest the article of L. A. Cowles on "Effect of the College on Engineering," in the June 1 issue and also the letters on this same subject that preceded it. As a member of the old school of practical experience, I should like to add a few words in support of the "old timers" who have come up through an age when the up-to-date engineering education and textbook literature was far from its present proficiency. The college professor lacked the qualifications of today. Engineering was in its infancy, so to speak, as compared with the present time. The old school wrote into textbooks from practical experience much of our up-to-dateness. There was no established formula in many instances, and the engineer had to lay aside his collar and tie, roll up his sleeves and dig it out for himself. I should like to impress upon the minds of the younger college graduate of today, that there is just as much need today as ever before for the practical engineer. He was the man who made it possible for you to attain your standing in the engineering profession.

There are undoubtedly many engineers who should have been surgeons, lawyers, etc. But not so much so with the old school of practical experience. These men have stuck, for the love of the art. Compensation had little or no attraction. Applause was not sought. Results were what counted.

It would appear that our present-day executives fail to realize the status of the old timer. There is a tendency to crowd him into the background. Just because he didn't have the opportunity of a college education, should his deeds of an honorable and faithful life be entirely ignored? Let me ask that he be treated with the courtesy due him.

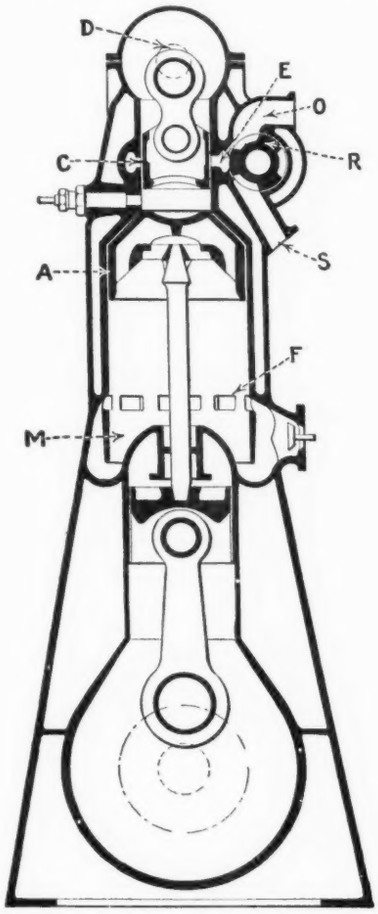
There is something more than skill and education in the makeup of an engineer. He must have a heart for his fellowman. ARTHUR C. HERREN.

Kokomo, Ind.

A Supercharging Diesel

Some time ago in an editorial a very favorable comment was made upon the combination of Diesel engines with exhaust-gas turbines.

It is without a shadow of a doubt that the combination of Diesel engines with exhaust-gas turbine-driven superchargers is receiving a growing appreciation because it seems to be the most adequate means of realizing considerable improvement in the performance of internal-combustion engines, especially when the four-stroke-cycle type is concerned. The advantages to be



Four-stroke-cycle engine with supercharging

obtained by such combined machinery include a possible decrease in specific fuel consumption, as well as considerably higher outputs per unit weight of machinery. But there are certain constructional details that deserve strict attention if the machinery is to work reliably on long endurance runs.

With the supercharger in operation the exhaust-gas temperature is being increased, in some instances, well above 1,000 deg., which means that the average working temperature of the Diesel engine may go beyond desirable limits. An excessive mean working temperature may cause evaporation of the lubricating oil within the crankcase, etc. The exhaust valves have to be reground much more often. In addition, an increased amount of cooling water is needed.

As the Diesel engine is working under conditions of increased heat stresses, there is danger that if no proper precaution be taken, the useful life of the engine may decrease to a marked extent.

In order to overcome these adverse conditions, I suggest that there be introduced an efficient scavenging means for both the turbine and the Diesel engine, thus reducing the mean working temperature of the plant. Poppet valves should be eliminated altogether. Other working parts, rotary valves or deflector valves, as the case may be, should be so arranged that they are not in direct contact with the interior of the cylinder during the combustion period and should also be provided with the simplest and most efficient cooling means. Owing to the increased heat stresses, cylinder covers with their complicated internal structure might well be eliminated.

In due consideration of these points, I propose the construction of four-stroke-cycle Diesel engines along the lines shown in the illustration.

There are two parallel crankshafts, the main crankshaft and *D* the half-speed crankshaft. The main piston *A* controls a row of openings *F* through which, during a portion of every revolution of the main crankshaft, highly precompressed air is admitted into the cylinder: (1) After every working stroke for the purposes of thorough scavenging of the working cylinder; (2) at the end of every suction stroke for the purposes of supercharging.

The half-speed piston *C* controls the row of openings *E*, keeping them open during the entire period of the exhaust and suction stroke and, on the other hand, holding them closed during the compression and working strokes. A simple rotary valve *R* or an oscillating deflector valve set at a right angle to the axis of the cylinder will establish the alternate communication between the ports *E* and channels *S* during the exhaust period and ports *E* and channels *O* during the suction period.

The combustion chamber, situated within the smaller portion of the cylinder, is of nearly spherical formation. By the special form of the working cylinder and the upper portion of the main piston *A* provision is being made to cause active turbulence within the combustion chamber.

Within the lower portion of the cylinder there is the pre-compression space *M* wherein the piston *A* precompresses a charge of atmospheric air if a blower is not used, or the piston provides for an additional precompression of a charge of air already precompressed within the blower if it is in operation. The chief principle is to admit precompressed air of a higher pressure than is the pressure of the air charge which is being admitted into the working cylinder during the greatest portion of the suction stroke through the channels *O* and ports *E*.

As to the question of scavenging the working cylinder after every working stroke, it is to be kept in mind that with the blower out of commission the supercharging of the cylinder is moderate, the mean working pressures and temperatures are not considerable. With the blower in operation the m.e.p. within the cylinder may be increased well over 14 atm., but as the scavenging air within the space *M* will be precompressed to a fairly high degree, its cooling power will help to keep down the mean working temperature. The effectiveness of this cooling system will reveal that water cooling for the pistons can be dispensed with.

There will be no remarkable drop in the pressure of the working fluid transferred from within the Diesel engine into the turbine.

CHARLES J. TOTH.
Montevideo, Uruguay.

The Coal-Dust Engine

In the editorial on the coal-dust engine on page 23 of the July 6 issue, it is suggested that the Humphrey gas-pump principle could be used with a view to avoid possible cylinder and piston wear. If this combination proved a commercial success, we could replace many low-lift, low-efficiency centrifugal pump installations in Holland, where some pumping stations are working day and night during the fall and winter to get rid of a surplus of water in agricultural districts, thus saving yearly a tremendous amount of money. In these plants the water is simply discharged to a higher plane and no waterwheel is necessary, and this adds materially to the simplicity and efficiency of the installation.

For small power plants the first cost, however, would be prohibitive and a relatively large amount would be spent on building construction in order to house the required column of water necessary to compress the charge of air. Is it not feasible to construct a special piston for a coal-dust engine that would keep the products of combustion entirely away from the machined and fabricated surfaces of the piston and cylinder liner? If efforts in this direction were successful, the coal-dust engine would become a keen competitor of the electric motor for combined and individual drives.

Enschede, Holland. H. WIELAND LOS.

Lack of Standardization Causes High Power Cost

In his article in the June 1 issue on "Lack of Standardization Causes High Power Costs," A. F. Sheehan advocates the standardization of power equipment and operating methods for industrial plants and points to the work of the N.E.L.A. as an example of what might be done to improve conditions.

Undoubtedly, improvements could be brought about if it were possible to induce the owners of textile and other industrial plants to follow the course suggested by Mr. Sheehan, but whether this would lead to the best solution of the rather wide range of problems involved is a matter of some doubt.

In the case of the N.E.L.A. we have an organization supported by a highly specialized industry engaged in the manufacture and distribution of one product, electrical energy. Among the different concerns supporting the organization there is practically no competition; their problems are to a large extent identical, and the knowledge which it is desired to place at the disposal of the industry at large is mostly in the possession of individuals associated with the member companies. The N.E.L.A. therefore provides a clearing house for this special information. Moreover, the point should not be overlooked that the N.E.L.A. costs a good deal of money, which is willingly furnished by the companies chiefly profiting by its work.

Now this question of money is the crux of the whole situation. Almost any industrial concern can have a well planned and economically operated power plant if it is willing to pay for it, but that is something too many of them are not willing to do, and some of them are not in a position to do.

Independent competent engineering advice is too often looked upon as being an unnecessary luxury, and it is the province of the sales engineer to confirm this opinion in connection with the purchase of his own equipment. At any rate, it would appear that it would require the carrying out of a program of intensified education if the idea of adequate engineering service is to be sold to the public.

This is not intended as a criticism of the methods of the sales engineer. He has something to sell and he is justified in trying to make a sale whenever his equipment could reasonably be used. He would be more than human if he were to advise his prospect to pay another engineer to tell him why some other make of equipment could be used to better advantage.

Many operating engineers are no doubt technically qualified to advise their employers as to mechanical improvements in the power plant, but unfortunately they are seldom in a sufficiently independent and detached position to discuss in an authoritative manner the many economic factors involved, or to demand information, often of a more or less confidential nature, relating to the business as a whole.

Those who have not engaged in consulting work would be surprised to find what a large proportion of the advisory engineer's problems are not of a strictly engineering nature at all. He is much in the position of a physician; to prescribe an ideal course of treatment may be a comparatively simple matter, but to prescribe one which the patient both can and will carry out, and which will at the same time offer a reasonable prospect of improvement, is something that requires a considerable amount of judgment and diplomacy. Remedies that the patient will not take are useless.

The management of a manufacturing plant has many other problems than that of obtaining economical power; that is only one of them, and sometimes by no means the most important.

In many cases the cost of power is not more than 10 per cent of the total cost of production, and a 20 per cent saving in power costs would represent only 2 per cent of the cost of the product.

It is true that this 2 per cent is not to be ignored, but it is obvious that the question of spending money on the power plant is one that should not be considered from the viewpoint of power production alone. The financial condition of the business as a whole has to be given careful consideration, and this is a special problem in each individual case.

We are always faced with the necessity of doing the best possible under the circumstances, and sometimes that best is not much. It is therefore doubtful whether the establishment of universal standards of practice would be of much advantage.

It is perhaps not efficient to discuss the value of engineering service in an engineering journal, because in most cases the man we want to get the idea across to is a layman. At the same time it will do no harm to consider some of the factors involved.

There is a rule more or less followed by physicians, not to practice upon themselves or members of their immediate family, for reasons somewhat similar to those already referred to, and it might be worth considering whether engineers could not sometimes follow a similar rule to advantage. It is not so much a question of one's own technical knowledge as of one's own strategical position, and also the fact that the ignoring of such a policy often causes engineers to confirm the impression that independent investigation and detached technical advice are not worth paying for.

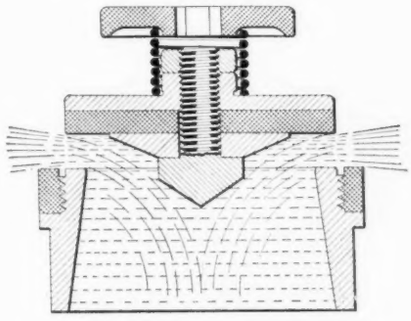
Newark, N. J. J. O. G. GIBBONS.

New and Improved Equipment

Williams-Bullen Pump Valve

A type of pump valve in which there are no webs on the inside of the seat has been brought out recently by the Williams Gauge Co., Pittsburgh, Pa.

Referring to illustration, the valve disk proper, with its renewable face of



Valve designed to give stream-line flow

"Wigaco," is held to its seat by a spring resting against a yoke that is screwed to the top part of the valve seat. The valve body is of bronze, as is also the stud which holds the renewable disk in place. By omitting the usual webs from the inside of the seat, the velocity and fluid friction are materially lessened and the efficiency increased.

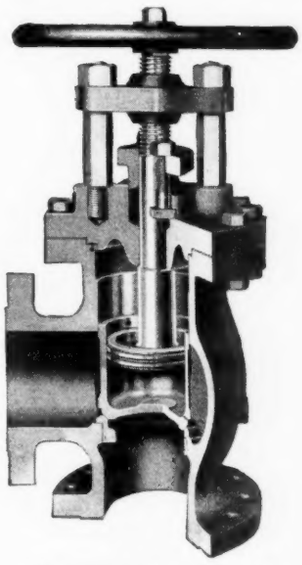
Edwards "Ferac" Non-Return Valve

The Edwards Valve & Manufacturing Co., East Chicago, Ind., has recently added to its line of specialties the non-return valve shown in the illustration.

This valve, which is designed for use with pressures up to 250 lb. and total temperatures of 500 lb., is known as "Ferac," this being the name given to the ferrous cast metal of which the body and bonnet are made.

Referring to the illustration, the valve disk is essentially a cylinder closed at one end, the interior forming a dashpot into which a piston on the end of the screwed stem is fitted. The rings used on the piston are made of thermalloy, an adaptation of a high-chromium ferrous alloy which it is claimed is non-corrosive and does not tend to grow in high temperatures, thus making it particularly adaptable to this kind of service.

The seat and disk of the valve are of hard steam bronze and the stem is of rolled steel. The disk is guided into the seat by means of body guides, thus eliminating the use of a spider and guide steam construction. In this way the seat area is practically 100 per cent of the pipe area and the passage through the seat is unobstructed.



Cut-away view of valve

The valves are built in globe, angle and elbow vertical patterns and in 4-, 5-, 6-, 7-, 8- and 10-in. sizes.

Chico Flat Suspended Arch

Use of thin tile made of high-grade flint clays in shapes free from sharp grooves and slots to avoid cracking, the use of the round-hole principle for support and the grouping of these tile into flexible suspended units giving freedom of movement to permit expansion or contraction without stress, are the features of the new Chico flat suspended arch developed recently by the Chicago Fire Brick Company, 111 West Washington St., Chicago.

As shown in Fig. 1, the arch is made up of units comprising four fireclay tile, suspended two on either side of a central hanger rod attached to a horizontal bar passing through round holes in the tiles. The required number of these units are suspended by the rods

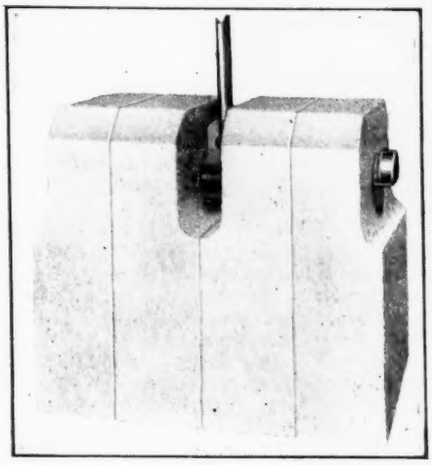


Fig. 1—Chico arch unit made up of four tile

from structural-steel beams spanning the furnace, as indicated in Fig. 2. At the knee of the arch unit construction with radial tile and special bracket support is followed. A feature is a square shoulder at the base of the bracket to hold the fantail end of the arch in balance should any of the horizontal units back of it be removed. Any contour of arch can be provided to suit the requirements of the installation.

Ventilation of the entire arch keeps the metal hangers and the tile at com-

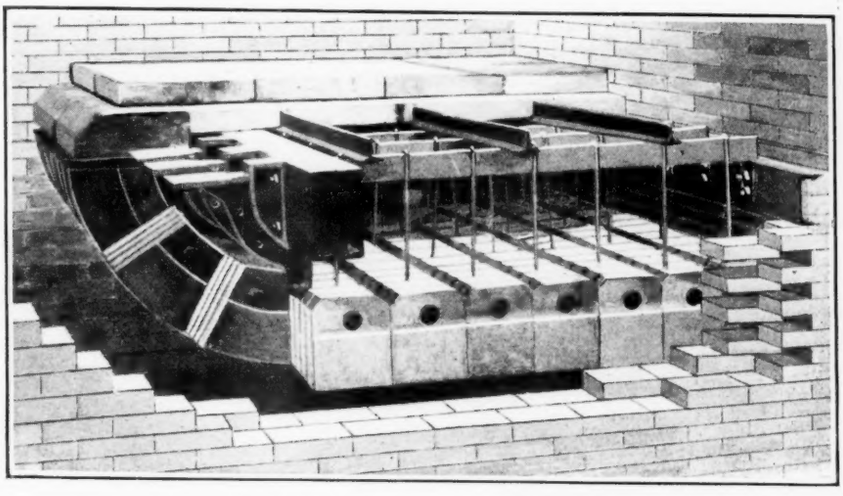


Fig. 2—Chico flat suspended arch

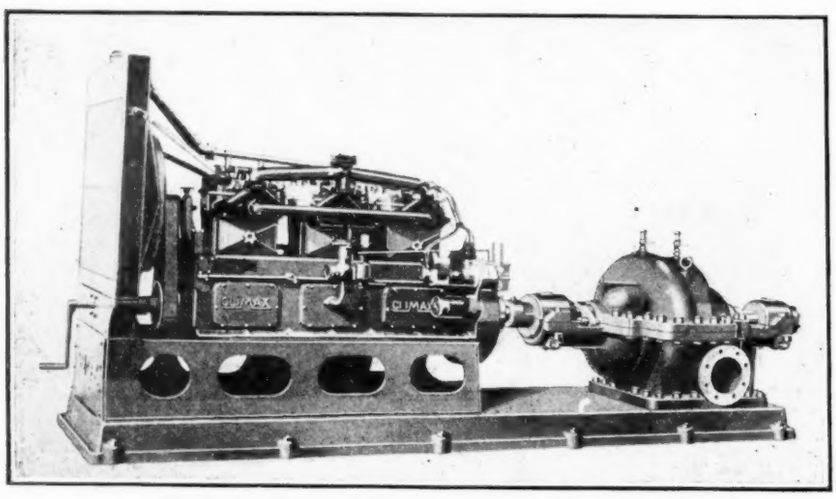
paratively low temperatures. Only one end of the tile is exposed to the fire, and as there is freedom of motion between integral parts, and, with the hanger bar free to rotate within the tile, no binding action, the tile may burn down to the round-hole support before there is need for replacement. When necessary, any one of these four-tile units may be replaced without disturbing the arch as a whole, and the supporting rod may be bent at any point to adjust the height of the new tile to that of the tile in service.

Climax Engine Pumping Units

The employment of gasoline-engine pumping units for standby fire protection is becoming a feature of most water works where electric energy is used to drive the main pumps.

The Underwriters' Laboratories, Inc., have been very strict in the requirements to be met before a gasoline engine is placed on the approved list. Recently the Climax Engineering Company, Clinton, Iowa, obtained approval of two models of its medium-speed industrial gasoline engines, Models R4U and R6U, for driving 750 and 1,000 gal. per min. pumps. The engines are made with either four or six 6x7-in. cylinders, and are equipped with water circulating pumps, necessary manifolds, built-in governor, hand-starting crank and dust-proof priming cups. Dual ignition is provided, consisting of a Bosch magneto with impulse starter and Bosch distributor and coil with two spark plugs per cylinder head. The carburetor is Stromberg with special jet setting. A tachometer is furnished and installed on the engine, and the "Oil-Vac" vacuum tank and vacuum pump insure a constant supply of fuel.

For a completely equipped power unit, a pair of cast-iron side rails upon which the engine may be mounted and an extended sub-base for mounting the driven unit, are available. A cast-iron shell radiator with ample surface may be obtained for cooling. This is equipped with fittings for mounting on the engine support, and is connected to the engine, which also has a 24-in. belt-driven cooling fan. Should the engine be direct connected to the driven unit, a flexible coupling is provided and as an alternative, an inclosed clutch, or power take-off.



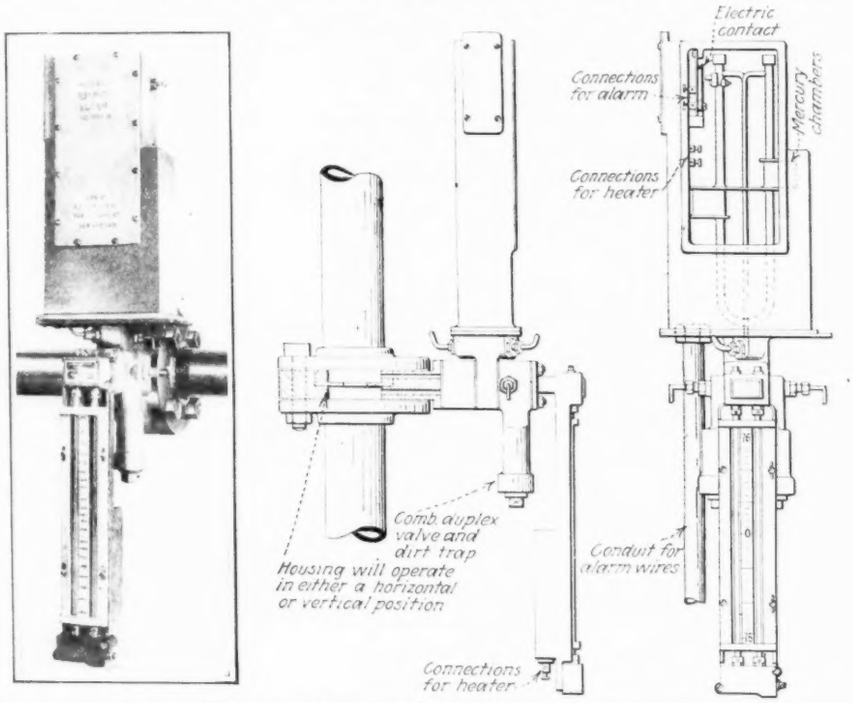
Climax fire pump set

Hanson Flow Indicator with No-Flow Alarm

The flow indicator (Type B) and no-flow alarm shown in the illustration is a recent development of Roy E. Hanson, 5231 Navarro St., Los Angeles, Calif. The indicator is designed on the orifice principle and registers the flow (either in gallons per minute or pounds per hour) directly on a scale.

The instrument is composed of an orifice housing with a removable orifice, a combination duplex valve and dirt trap and an indicator body. The orifice housing is designed to fit between companion flanges in either a horizontal or vertical plane, the flanges on all housings being made similar to permit the use of the same valves and indicator for all sizes.

The illustration shows the indicator, which consists of a standard U-tube with both legs visible, attached directly to the orifice housing. It can, however, be placed some distance from the orifice housing and suitable connections made between. The combination duplex valve and dirt trap is designed as a separate unit and is placed between the orifice housing and indicator body as shown. The valves are to control the pressure to the U-tube, and the dirt trap keeps the U-tube free of foreign matter.


Electric contact
Connections for alarm
Mercury chambers
Connections for heater
Comb. duplex valve and dirt trap
Housing will operate in either a horizontal or vertical position
Conduit for alarm wires
Connections for heater

Assembled view and section showing constructional features

The no-flow alarm is made a complete unit in itself and is arranged for placing between the orifice housing and the duplex valve or for use as a separate unit. It is designed to ring an alarm when the flow in the pipe line stops or reaches a predetermined amount. It operates from the differential pressure created at the orifice and consists of a U-tube having reservoirs, which are filled with mercury, placed at different levels. The mercury passing from one reservoir to the other causes the U-tube to deflect, which in turn operates contact points that ring the alarm when the flow stops through the instrument.

The instrument has been designed to be suitable for either outdoor or indoor installations, and where climatic conditions demand it a heating coil is built integral with the instrument to prevent freezing. A type A flow indicator for use in vertical lines only is also available.

The volume of one pound of a gas under standard conditions of 68 deg. F. and 14.7 lb. per sq.in., is very closely 385 divided by the molecular weight of the gas.

N.E.L.A. Proposes Piping Specifications

Lap-Welded and Seamless Steel Pipe for High Temperatures

SPECIFICATIONS, as recently proposed by the Prime Movers Committee, N.E.L.A., cover lap-welded end seamless steel pipe for pressures of 250, 400, 600, 900 and 1,350 lb. and temperatures up to 750 deg. F. or higher, with appropriate pressures at the discretion of the designing engineer. Reference is made to the dimensional standards reproduced in the table, as formulated under the procedure of the American Engineering Standards Committee.

Process of Manufacture

It is provided that the steel for lap-welded pipe shall be of soft weldable quality, made by the open-hearth process, and that for seamless pipe shall be made by the open-hearth or electric-furnace process. All welded pipe of 2-in. nominal size and over shall be made by the lap-weld process; all pipe 1½-in. nominal size or smaller by the seamless process; and unless otherwise specified, seamless tubing shall be furnished hot finished or annealed.

Chemical Composition.—The steel for welded and seamless pipes shall conform to the following requirements as to chemical composition:

	Welded	Seamless
Phosphorus, per cent—not over	0.06 (Note 3)	0.04
Sulphur, per cent—not over	0.05	0.05

The following physical properties are prescribed:

	Welded	Seamless Low Carbon	Seamless Medium Carbon
Tensile strength, lb. per sq.in.	45,000	47,000	62,000
Welded point, lb. per sq.in.	25,000	27,000	35,000
Elongation in 2 in.	40%	40%	25%

Furthermore, it is specified that pipe shall withstand the following hydrostatic test pressures, welded pipe being struck near both ends, while under pressure, with a two-pound hammer or equivalent.

Class of Pipe Working pressure Lb. per Sq.In.	Standard Test Pressures Lb. per Sq.In.
250	750
400	1,000
600	1,500
900	2,000
1,350	3,000

The above test pressures are the minimum test pressures desired on the finished product, and wherever feasible the mill is to test at least up to these pressures. In the case of sizes of pipe which require flanges or special end connections for routine testing under high pressure, unless otherwise stated in the order, the mill is to test at the highest pressure which is feasible for that size of pipe, without special equipment. The purchaser may then apply the standard test pressure (as above) to the fabricated pipe and this test is to have the same significance as though it had been applied at the mill.

The weight of the pipe shall not exceed that specified in the table by more than 5 per cent for the 250-, 400- and 900-lb. standard, nor more than 10 per cent for the 1,350-lb. standard.

Unless otherwise specified, the pipe shall be furnished as to lengths, in accordance with the regular practice: (a) 250- and 400-lb. pipe shall be in random lengths of 16 to 22 ft. When ordering plain ends, 5 per cent may be in lengths of 16 ft. (b) 600-, 900- and 1,350-lb. standard shall be in unjointed random lengths of 12 to 22 ft.

Other provisions of the proposed specifications deal with workmanship, methods of testing, inspection, etc.

Canada Power Projects Need $1,300,000,000—1926-45

A study of probable capital requirements for development of Canadian water power, the results of which are now published in the monthly letter of the Royal Bank of Canada, indicates that between 1926 and 1945 nearly $1,300,000,000 will be needed, making an average of nearly $65,000,000 a year.

The estimate has been made by the Dominion Water Power Branch of the Department of the Interior.

DIMENSIONS AND WEIGHTS OF PIPE FOR 250, 400, 600, 900 AND 1,350 LB.

Nominal Pipe Size	Outside Diameter, Inches	Threads per Inch	250 Lb. Wall Thickness, Inches	250 Lb. Weight per Linear Foot, Plain Ends	400 Lb. Wall Thickness, Inches	400 Lb. Weight per Linear Foot, Plain Ends	400 Lb. Wall Thickness, Inches	400 Lb. Weight per Linear Foot, Plain Ends	600 Lb. Wall Thickness, Inches	600 Lb. Weight per Linear Foot, Plain Ends	900 Lb. Wall Thickness, Inches	900 Lb. Weight per Linear Foot, Plain Ends	1350 Lb. Wall Thickness, Inches	1350 Lb. Weight per Linear Foot, Plain Ends
			SEAMLESS OPEN HEARTH PIPE				SEAMLESS OPEN HEARTH PIPE							
⅛	0.840	14	0.109	0.850			0.109	0.850	0.147	1.087	0.147	1.087	0.147	1.087
¾	1.050	14	0.113	1.130			0.113	1.130	0.154	1.473	0.154	1.473	0.1875	1.727
1	1.315	11½	0.133	1.678			0.133	1.678	0.179	2.171	0.179	2.171	0.21875	2.561
1¼	1.660	11½	0.140	2.272			0.140	2.272	0.191	2.996	0.191	2.996	0.250	3.764
1½	1.900	11½	0.145	2.717			0.145	2.717	0.200	3.631	0.200	3.631	0.28125	4.862
			LAP WELDED OPEN HEARTH PIPE				SEAMLESS OPEN HEARTH PIPE							
2	2.375	11½	0.154	3.652	0.218	5.027	0.167	3.938	0.1875	4.380	0.250	5.673	0.3125	6.883
2½	2.875	8	0.203	5.793	0.276	7.661	0.203	5.793	0.217	6.160	0.276	7.661	0.375	10.012
3	3.500	8	0.216	7.575	0.300	10.252	0.216	7.575	0.241	8.388	0.3125	10.638	0.40625	13.423
3½	4.000	8	0.226	9.109	0.318	12.505	0.226	9.109	0.28125	11.170	0.34375	13.423	0.46875	17.678
4	4.500	8	0.237	10.790	0.337	14.983	0.237	10.790	0.28125	12.672	0.375	16.520	0.500	21.360
5	5.563	8	0.258	14.617	0.375	20.778	0.258	14.617	0.352	19.590	0.4375	23.949	0.625	32.961
6	6.625	8	0.280	18.974	0.432	28.573	0.288	19.491	0.385	25.658	0.500	32.707	0.6875	43.596
8	8.625	8	0.322	28.554	0.500	43.388	0.34375	30.402	0.46875	40.832	0.625	53.400	0.875	72.424
10	10.750	8	0.365	40.483	0.500	54.735	0.395	43.684	0.53125	57.979	0.750	80.101	1.0625	109.930
12	12.750	8	0.375	49.562	0.500	65.415	0.500	65.415	0.625	80.935	0.875	110.973	1.21875	150.095
14	14.0	8	0.40625	58.980	0.625	89.279	0.500	72.091	0.65625	93.524	0.9375	130.790	1.34375	181.635
16	16.0	8	0.46875	77.754	0.6875	112.433	0.53125	87.771	0.750	122.154	1.03125	164.864	1.500	232.293
18	18.0	8	0.500	93.451	0.750	138.174	0.59375	110.379	0.8125	149.146	1.15625	208.002	1.6875	293.996
20	20.0	8	0.5625	116.772	0.875	178.725	0.625	129.330	0.90625	184.806	1.28125	256.146	1.84375	357.524
24	24.0	8	0.625	163*	0.9375	240*	0.750	186.235	1.03125	252.975	1.500	360.455	2.1875	509.602
SPECIAL SIZES			LAP WELDED OPEN HEARTH PIPE				SEAMLESS OPEN HEARTH PIPE							
4½	5.000	8	0.247	12.538	0.355	17.611	0.250	12.682	0.3125	15.644	0.40625	19.931	0.5625	26.658
7	7.625	8	0.301	23.544	0.500	38.048	0.3125	24.405	0.40625	31.320	0.5625	42.428	0.78125	57.105
9	9.625	8	0.342	33.907	0.500	48.728	0.375	37.046	0.500	48.728	0.6875	65.624	0.96875	89.561
15	15.0	8	0.4375	68.044	0.625	95.954	0.500	77.431	0.6875	105.091	1.000	149.522	1.40625	204.164
17	17.0	8	0.500	88.111	0.6875	119.776	0.5625	98.749	0.78125	135.327	1.09375	185.807	1.59375	262.237
22	22.0	8	0.625	148*	0.875	204*	0.6875	156.489	0.96875	217.597	1.375	302.882	2.000	427.206

*Hammer weld pipe approximate manufacturing weight.

News in the Field of Power

Boiler Explosion Kills Two at U. S. Naval Engineering Experiment Station

Two Others Injured When Head of Express Type Marine Boiler Blows Off—Crack Inside of Head—Probably Due to Breathing Action

FOUR men were injured, two of them fatally, when a boiler explosion occurred at the United States Naval Engineering Experiment Station on the Severn River, near Annapolis, Md., shortly past noon of August 17. The boiler house was badly damaged.

The boiler was oil fired and of the so-called express type of marine style, that is, with a single longitudinal steam drum connected by the tubes to a lower longitudinal mud drum at each side. It was rated at 500 hp. on the land rating of 10 sq.ft. of heating surface.

Fatigue Thought Cause

Failure developed in the rear head of the steam drum. The entire head was carried away, due to a fracture extending around the head along a line at the beginning of the sharper curvature toward the flange. The joint between the head and the drum was intact. Examination of the fracture indicated that a gradual failure of the metal along the line mentioned had been taking place, particularly throughout the portion that was below the water line. This is believed to have been due to the fatigue of the metal resulting from the "breathing" of the head, combined probably with corrosion.

Pressure Normal

Fresh soft water without compounds had always been used for feed. There was no evidence elsewhere of any corrosion or pitting. Since the crack was on the inside of the head in the bend of the metal, it evidently closed tightly when the boiler was cold, thus avoiding detection. Thorough inspection had been made in March, 1926. A recording gage showed that at the time of the explosion the pressure was 310 lb., which was 5 lb. below the safety-valve setting and not an unusual working pressure. The water was at a suitable level. Service had been more or less regular for 15 years.

Installed in a closed fireroom, as is common in Naval practice, the boiler was not being operated under forced draft. Fortunately, it was the only boiler under steam at the time, else the casualties might have been greater. Other fortunate circumstances were that the explosion occurred during the noon hour when most of the employees were outside and that no oil fire resulted. As it was, two civilian employees were fatally injured, one the fireman on watch and the other an attendant who was blowing tubes nearby.

The action was interesting owing to the reaction of the steam, issuing as it did from the upper rear of the boiler, the entire boiler was capsized forward and then spun about in one corner, finally resting upside down and end foremost from the original position. The rear and side bulkheads of the fireroom held, although badly battered and bulged. It was the front bulkhead that blew out. Much damage was done to the roof structure of the building and to near-by equipment.

Appointed by Rear Admiral Louis M. Nulton, superintendent of the Naval Academy, a board is conducting a complete investigation.

Some A. I. E. E. Appointments for the Coming Year

At the first meeting of the board of directors of the American Institute of Electrical Engineers for the administrative year beginning Aug. 1, 1926, held in New York City on Aug. 10, President Chesney announced the committee appointments for the administrative year beginning Aug. 1, 1926.

The chairmen appointed to some of the more important of the general committees are as follows: Sections, Harold B. Smith, professor of Electrical Engineering, Worcester Polytechnic Institute, Worcester, Mass.; meetings and papers, E. B. Meyer, chief engineer, Public Service Production Co., Newark, N. J.; publication, L. F. Morehouse, equipment development engineer, American Telephone & Telegraph Co., New York City; membership, L. S. O'Roark, employment director, Bell Telephone Laboratories, Inc., New York City; award of institute prizes, E. B. Meyer, chief engineer, Public Service Production Co., Newark, N. J., and to head the committee licensing of engineers, Francis Blossom, Sanderson & Porter, New York City.
Porter, New York.

Elliott Co. Buys Ridgway Dynamo & Engine Co.

Purchase of the extensive plant of the Ridgway Dynamo & Engine Co., at Ridgway, Pa., together with the good will and other assets of the company, has been made by the Elliott Company, of Pittsburgh, now operating plants at Jeannette, Pa., Springfield, Ohio, and Wellsville, N. Y., and with branch offices at principal business centers.

The Ridgway Dynamo & Engine Co. has been a successful manufacturer of steam and electric machinery for over thirty years, and enjoys an excellent reputation. Under Elliott Co. management the Ridgway plant will be improved, production increased and sales work aggressively pushed.

This acquisition is a further step in the expansion program of Elliott Co., which in recent years has been extending and developing its power machinery business. Less than two years ago the Kerr Turbine, formerly manufactured by the Kerr Turbine Co., of Wellsville, N. Y., was added to the list of Elliott products.

With the addition of the Ridgway line the Elliott Co. organization is manufacturing a very complete group of power equipment, including steam turbines and generators, several different types of engines, all types of condensers, feed-water heaters, air ejectors, deaërators, motors and electrical machinery, as well as smaller items such as strainers, filters, valves and boiler-tube cleaners.

New Brunswick Development Formally Inaugurated

Actual development of the hydroelectric plant at Grand Falls on the St. John River was formally inaugurated August 10. Men prominent in the public life of New Brunswick were the guests at ceremonies which culminated with the pressing of an electric button setting off a blast near the pitch of the falls.

The International Paper Co. is carrying out the project, which for several years was a matter of international negotiations and which was a leading issue in the provincial elections last fall. The former Liberal government of New Brunswick had pushed through the Legislature a bill for development of the falls by the province at an estimated cost of $8,000,000. With the political overturn in last year's elections the new Conservative government upset this plan and the International Paper Co. finally acquired all the property and development rights involved.

As about half of the drainage area of the river above the falls is in the State of Maine, the International Joint Waterways Commission was called upon to rule on the provincial development plan. The commission last year approved the development conditional upon the supplying of 2,000 hp. to points in Maine.

It is expected that from 50,000 to 70,000 hp. can be developed at the falls, which are regarded as the greatest potential natural water power in Canada east of Niagara. The construction work will be carried out for the paper company by the Dominion Construction Co. A large main dam will be erected.

Site of Water Power Located in Alaska

The Navy Aërial Survey Expedition now making aërial photographs of Alaska has discovered excellent water-power possibilities at Lake Grace, according to an announcement, August 11, by the Navy Department.

Secretary of the Navy Wilbur recently arrived in Alaska to inspect the work of the Survey. Text of the report of the Survey's recent work, as made public at the Navy Department, states in part:

A large lake, locally known as Lake Grace, has been shown by the photographic work to hold excellent possibilities for the development of great water power. It was to obtain such information about this heretofore nearly inaccessible country that the Navy Expedition was sent to Alaska to co-operate with the Department of Interior.

The expedition has mapped fifteen islands and Cleveland peninsula, as well as a part of another large island. Two daily flights are made by two planes working together.

Engineers Prominent in New Bureau of Mines Formation

An unusually large proportion of the staff of the Bureau of Mines hold degrees in engineering. Director Scott Turner feels that this is one of the assets of the Bureau, and the term is to be incorporated in titles wherever possible.

In the new plan of organization the head of each branch is to be called chief; the head of each division is to be known as chief engineer; the head of each section is the supervising engineer; and the head of each unit is the engineer-in-charge. This form of descending scale will be carried out as far as possible in the entire plan of organization.

Duluth Rushes Power Program

Several major construction projects of the Minnesota Power & Light Co., part of the $1,500,000 improvement program for Duluth and northern Minnesota announced last spring, are nearing completion, S. W. Robertson, vice-president and general manager, has announced.

Operation is scheduled early next month.

These projects include construction of the new terminal substation at Fifteenth Avenue west, the new switching station at Fond du Lac and the new transmission line from Fond du Lac to the new substation and the completion of the Commerce Street transformer and switching station.

Duquesne Light Co. Plans Large Installations

A large contract from the Duquesne Light Co., of Pittsburgh, calls for one turbine generator of 60,000 hp., one 62,500-sq.ft. steam condenser with auxiliaries and three transformers, each rated at 31,400 kva. The equipment is for the Colfax station at Cheswick, near Pittsburgh.

The Binghamton Light, Heat & Power Co. has ordered one 45,000-hp. turbine generator and three transformers rated at 11,765 kva. each. The equipment is for the company's station at Binghamton, N. Y. The Westinghouse Electric & Manufacturing Co. will fill both of these orders.

Big Utah Power & Light Project May Rest

The Utah Power & Light Co. has applied to the Federal Power Commission for a license in accordance with its preliminary permit of August 15, 1923, covering the company's proposed development at Flaming Gorge on the Green River. Plans call for the construction of a concrete gravity dam 875 ft. long and 270 ft. high, creating a reservoir sixty miles long with an area of 37,200 acres. Equipment sufficient to develop 63,000 hp. will be installed.

Under a resolution adopted by the commission last year, no action is to be taken on any application on the Colorado River or its tributaries, pending an agreement among the states of the basin as to allocation of water. Despite the importance of the Flaming Gorge project, which would regulate completely the Green River above the dam, it seems improbable that the commission will make any exception in this case.

American Firm Plans To Electrify Poland

The Polish government is reported to be negotiating with the American-European Utilities Corp. regarding electrification of Upper Silesia and the districts of Cracow and Warsaw.

The American-European Utilities Corp. is sponsored by the Wall Street banking firm of Bertron, Griscom & Co. The firm for months has had engineers in Poland making studies with a view to taking over the electrification of the southwestern parts of Poland and the development of hydro-electric energy in the Carpathian Mountains. It was said at its offices that there would be no public financing as a result of the present negotiations.

Soft Coal Output for 1926 Ahead of 1925 Period

Production of bituminous coal during the first half of 1926 ran 14 per cent ahead of production during the same period of 1925. Likewise, consumption of coal has been larger than in any previous year.

Though production is less than in 1918, a large part of the output in that year was going into storage, whereas in 1926 consumers have been drawing on storage. Actual consumption and exports of bituminous coal in 1918, allowing for changes in stocks, were 551,000,000 tons. During the first five months of 1926 the country was consuming and exporting coal at the rate of 555,000,000 tons for the year. This figure discounts the extra demand to replace anthracite during the strike.

Eight N. Y. Power Concerns Form Merger

The merger of eight New York utility companies with the Moravia Electric Light, Heat & Power Co., was made known Aug. 13.

The companies merged with the Moravia Co. are as follows: the Southern New York Power Co., the New Berlin Light & Power Co., the West Branch Light & Power Co., the Sullivan County Light & Power Corp., the Delaware County Electric Light & Power Co., the Waterville Gas & Electric Co., the Madison Power Co., Inc., and the Fleischmann Light, Heat & Power Corp.

New Quarters for Cincinnati Engineers' Club

The Engineers' Club of Cincinnati has leased part of the Athletic Building of the Cincinnati Club, and is now remodeling it for new quarters, including a large meeting room, lounging and game room, a library and kitchenette. It is expected that the new quarters will be ready for occupancy by Sept. 1.

Alaska's Largest Power Plant Begun

Construction of a $1,750,000 power house, the largest in Alaska, for the Fairbanks Exploration Co. went under way Aug. 14. The structure is expected to be completed by 1928. It is to furnish power for dredges of the concern on Cleary and Goldstream Creeks, near Fairbanks.

Extension of Year Granted Project on Snake River

Extension of a year in the period of the preliminary permit held by the Idaho Power Co. for a water power project at Twin Falls, on Snake River, in Idaho, has been authorized by the Federal Power Commission.

The permit was issued April 30, 1924, and the period of extension is from April 30, 1926, to April 30, 1927.

Application was made by the committee for the extension in order, it is stated, to enable a continuation of investigational work.

Sale of Mechanical Stokers Reported as 125 for July

Twelve establishments manufacturing mechanical stokers in the United States have reported to the Department of Commerce that 125, with an aggregate horsepower of 50,494, were sold in July. Twenty fire-tube boilers with an aggregate horse power of 2,594, and 105 water-tube boilers, with an aggregate horsepower of 47,540, also were reported produced in that month.

Leipzig Technical Fair To Open

The annual technical fair of the City of Leipzig, Germany, which is a revival of the most famous European fair of the Middle Ages, will be held at the Leipzig fair grounds from Aug. 29 to Sept. 4, 1926. Last year this fair had 12,208 exhibitors.

Half-Year Electrical Output Tops 1925 by 12 Per Cent

Average daily production of electricity by public-utility power plants in the United States in June was 195,850,000 kw.-hr., about 4.5 per cent larger than the average daily output in May, according to a report of the Department of the Interior.

The total output for the first half of this year was 35,330,000,000 kw.-hr., an increase of about 12 per cent over the output for the same period in 1925 of 31,633,000,000 kw.-hr. These figures indicate that the total output for this year will probably be between 70 and 75 billion as compared with 65,870,000,000 in 1925.

Philadelphia Electric Has Unusual Transformers

The Philadelphia Electric Co. has recently installed in its Schuylkill station the largest self-cooled single-phase transformers built to date. The total capacity is 120,000 kva. in two banks. The complete transformers were shipped assembled in their permanent tanks, immersed in dry oil, thus eliminating the usual drying process. They are of General Electric manufacture, being of the standard core type, circular coil construction used by that company. The unit rating is 60 cycles, self-cooled, 20,000 kva., 72,450 volts (Y) to 13,800 volts (delta).

In addition to being unprecedented in size, these transformers are supplemented by separate voltage regulating transformers so connected into the main circuit at the neutral end of the high-voltage side as to afford a boosting and bucking effect over a total range of 10 per cent.

The equipment controls a tie line between the Schuylkill and Chester stations of the Philadelphia Electric Co. Similar provision for voltage variation had been made at the Chester end of the line some time ago, and the combination affords a flexibility of operation that is extremely valuable, owing to the constant variation in power demand at the respective stations.

The method used in the control of voltage embodies a new development of the General Electric Co. by which it is possible to vary the transformer ratio, either of the main power transformers or of auxiliary regulating transformers, without bringing the tap voltage leads out of the main transformers, and with only two circuit-breaking devices for each three-phase circuit.

This involves the use of two separate but identical circuits for the winding, which affords the voltage variation. These circuits are normally in parallel, but during times of voltage change, each circuit alternately carries the total load while the other is killed and undergoing tap change.

Austria Readjusting Her Electrical Industry

Austria possesses a large and well-developed electrotechnical industry with a capacity corresponding to the requirements of the former Austro-Hungarian monarchy, according to a report from Consul Robert W. Heingartner, Vienna, Austria. Production was reduced after the partition of the monarchy and the industry still is engaged in the process of adapting itself to the new situation.

Austrian imports of electrical machinery, apparatus and equipment of all kinds in 1925 amounted to about $4,108,100 and exports to about $8,438,600. Germany and Switzerland, which work through their Austrian subsidiaries, are the largest exporters to Austria, but various products of the American electrical industry are on sale. Austrian exports of electrial equipment consist chiefly of incandescent lamps, dynamos, telephone apparatus and cable. The exports are taken chiefly by the neighboring countries, but Austrian electrical equipment is found in the most distant markets. Although Austria has a large and efficient electrical industry, the country probably will continue to be a market for foreign equipment for some time, the consul states. The rapid development of water power is of great benefit, and with the increased use of cheap hydro-electric energy the demand for electrical apparatus is growing.

Smaller Profits Now Made In Manufacturing

Despite the abounding prosperity on the part of many individual business concerns, indications are that less of the consumer's dollar is going into manufacturing profit now than has been the case at any time since the War, with the exception of the critical year 1921, according to a study of manufacturing corporation incomes made by the National Industrial Conference Board, 247 Park Avenue, New York City.

The average net income per manufacturing corporation, taking into account only those reporting a net gain, in 1919 was $100,560, but only $79,411 in 1923, a decline of 21 per cent. Compared in terms of 1913 dollars to eliminate price changes, this shows an increase of 6 per cent in the average net gain per corporation in that group. But this, patently is due to the increased amount of business done, and does not represent an increased profitableness in the transaction of business.

More Losses

While the total number of all manufacturing corporations increased 25.5 per cent, from 67,852 in 1919 to 85,199 in 1923, those reporting a net income increased only 3.6 per cent, from 51,903 to 53,795, but those reporting no net income nearly doubled in number, increasing from 15,949 in 1919 to 31,404 in 1923. At the same time the total gross income of those corporations reporting no net income increased only from $6,584,702,815 to $7,534,069,100, which would seem to indicate that the incidence of business loss tends to fall more and more on concerns operating on a small scale. For, even in terms of 1913 dollars, to make the gross income figures for the two years comparable as indicating volume of business transacted, there was only a 53.6 per cent increase in the total gross receipts of these corporations operating unprofitably, although they increased 96.9 per cent in number.

Obituary

Charles D. Jenney, formerly manufacturer of electrical equipment in Indianapolis, died at his home in that city May 8. Mr. Jenney entered upon his career in the electrical industry at Ann Arbor, Mich., when he was seventeen years of age, later removing to Detroit. The year 1882 found him in Fort Wayne, Ind., as the organizer of the Fort Wayne Jenney Electric Co., which is now a branch of the General Electric Co. It was in 1885 that Mr. Jenney shifted his interests to Indianapolis. With Addison Nordyke, Amos K. Hollowell and Daniel M. Marmon he formed the Jenney Electric Motor Co., manufacturer of arc lights, motors and generators. He removed his plant to Anderson, Ind., in 1910. Mr. Jenney was born at Flint, Mich., Feb. 28, 1864.

Personal Mention

Charles P. Coleman has retired from the presidency of the Worthington Pump & Machinery Corp. and has been elected chairman of the board of the company.

James W. Watt, formerly chief engineer in the power house of the Crossett Lumber Co., Crossett, Ark., is now in a similar position with the Bradley Lumber Co., Warren, Ark.

Harris E. Dexter, of New York, has been appointed chief of the electrical equipment division of the Department of Commerce to succeed R. A. Lundquist, who recently resigned to enter private employ.

L. W. Helmreich, chief electrical and mechanical engineer for the Missouri State Public Service Commission, Jefferson City, Mo., has resigned to become general superintendent of the Jefferson City Water Co.

Ernest L. Blair, formerly with Lockwood, Greene & Co., Inc., as mechanical engineer in the steam department, has joined the Stone & Webster organization in its Boston office, as building service engineer in the structural division.

L. J. Belnap, until 1925 vice-president of the Rudel-Belnap Machinery Corp., Ltd., of Montreal, and formerly president of the Ingersoll Machine Co., Ltd., of Canada, has recently been elected president of the Worthington Pump & Machinery Corp.

F. E. Weymouth has severed his connection with Brock & Weymouth, Inc., as active head, although he remains a director and consultant of the company, and has been engaged by the J. G. White Engineering Corp. as chief engineer for work in Mexico.

K. H. Smith, formerly chief engineer of the Nova Scotia Power Commission, also district chief engineer of the Dominion Water Power and Reclamation

Service of the Maritime provinces, located at Halifax, is now associated with the Montreal Engineering Co., Ltd., Montreal. Mr. Smith retains his connection with the water-power branch in a consulting capacity.

P. J. Stevenson has joined the Penn Public Service Corp. as power engineer. Though not working directly for the company, Mr. Stevenson has been associated with it through various engineering jobs and has built up a wide acquaintanceship in the Philipsburg, Clearfield and Johnstown districts. He is a graduate of Pennsylvania State College.

Business Notes

The American Brown Boveri Electric Corp. announces the opening of a district sales office in Philadelphia at 922 Witherspoon Bldg. Louis T. Peck will be in charge.

The Bridgeport Brass Co. has moved its New York office from the Pershing Square Bldg. to the Farmers' Loan and Trust Co. Bldg., Suite 407, 475 Fifth Avenue, at Forty-first Street.

The Harnischfeger Corp., manufacturer of electric cranes announces that E. Lynn Puckett, of Richmond, Va., has been appointed district manager of the Charlotte office located at 1118 Independence Trust Bldg.

The Roberts Tool & Supply Co. of Syracuse, New York, has recently been appointed representative in that district for the line of IXL speed reducers and gear products manufactured by the Foote Bros. Gear & Machine Co.

The National Carbon Co., Inc., announces the appointment of Harry S. Schott as general sales manager, effective Aug. 1. Mr. Schott goes to his new office from the post of assistant general sales manager, which he has occupied for the last two years.

The Indianapolis Belting & Supply Co., 34 S. Capital St., Indianapolis, Ind., has recently been appointed Indianapolis territory representative for the IXL speed reducers and gear products, manufactured by the Foote Bros. Gear & Machine Co.

The Foote Bros. Gear & Machine Co. has acquired the services of H. G. Davis for the sales organization of the company. Mr. Davis, who was formerly associated with the Pfaudler Co., Milwaukee, Wis., will cover the north side of the City of Chicago and its suburbs.

The G. M. Davis Regulator Co., 422 Milwaukee Ave., Chicago, Ill., announces that Harvey R. Willard, power piping engineer, is now associated with the company as sales engineer. Mr. Willard will assist the trade in respect to the latest and best practice in the use of Davis valve specialties for the automatic regulation of pressure.

The Colossus Co., Inc., of Shreveport, La., will open a Western branch plant in Portland, Ore., in the Wilhelm warehouse on Everett Street. The company will distribute metallic rod packing, rubber and asbestos sheet packing, joint paste, pump valves and other boiler and engine room supplies.

The Equitable Meter & Manufacturing Co., producer of EMCO meters, regulators and appliances, with offices at New York City, Chicago and other points, has moved the headquarters and works of the company to Homewood, Pa.

Trade Catalogs

American H. S. Fans—The American Blower Co., Detroit, Mich. Bulletin No. 7003 deals with Class 15M. Characteristic curves are shown on chart. Capacity tables are given.

Coming Conventions

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Regional meeting at Richmond, Va., Sept. 27-30.

Association of Edison Illuminating Companies. Chateau Frontenac, Quebec, Sept. 27-Oct. 1. P. S. Millar, 80th St. and East End Ave., New York.

Empire State Gas and Electric Association. Lake Placid Club, N. Y., Sept. 30-Oct. 1. C. H. B. Chapin, Grand Central Terminal, New York.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state associations are scheduled for the following dates: **New York State Association,** Wilmer T. Meinzer, 3626-215 Place, Bayside, Long Island, N. Y. Postponed from June 11 to 12, at Troy, N. Y., to Sept. 12-13 at Atlantic City, N. J. **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

New England Water Works Association, Boston, Mass.; Annual Meeting, Providence, R. I., Sept. 14-17, 1926.

Pointer Gages — The Hays Corp., Michigan City, Ind., issues an illustrated leaflet on pointer gages for draft pressure and differentials manufactured by the company.

Gas Compressors—The Sullivan Machinery Co., 122 South Michigan Ave., Chicago, Ill., has issued a Catalog 83-C covering Sullivan gas compressors "WG-6," single stage, "WI-3" and "WJ-3," angle type. Illustrations of parts and installations, with tables of dimensions are given.

Speed Reducing Units—Philadelphia Gear Works, Philadelphia, Pa. Catalog 14 gives a very complete body of information on the worm and spur gear reducing units manufactured by this company, with many illustrations and descriptions of various types. Tables of ratings will make this cotalog of especial usefulness.

Steam Traps—The Armstrong Machine Works, Three Rivers, Mich., manufacturing specialists of traps, includes in the new Catalog E information on the complete line of traps produced by the company. Among the claims of the Armstrong trap are that air-binding is eliminated, valves are not scored and cut and there is no clogging or blow-off. The construction and application of this trap are explained and types and sizes designated. A capacity table and general information is supplied.

Optical Pyrometers—The Bacharach Industrial Instrument Co., Pittsburgh, Pa., has put out Bulletin 293 on the H-K optical pyrometer (Holborn-Kurlbaum). Several figures and curves showing correction for emissivity and true and apparent temperature are included. A table of applications and a table showing the method of making determinations and corrections, and instructions for the use of the optical pyrometer increase the value of the bulletin. The company has undertaken the publication of a house organ that should prove of much interest.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Aug. 16 1926
Pool 1	New York	$2.50@$3.75
Smokeless	Boston	2.21
Clearfield	Boston	1.70@ 2.00
Somerset	Boston	1.80@ 2.10
Kanawha	Columbus	1.50@ 1.75
Hocking	Columbus	1.40@ 1.75
Pittsburgh	Pittsburgh	1.60@ 1.90
Pittsburgh gas slack	Pittsburgh	1.20@ 1.30
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.15@ 2.50
West Ky.	Louisville	1.10@ 1.35
S. E. Ky.	Louisville	1.40@ 1.75
Big Seam	Birmingham	1.75@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	1.75@ 3.50
Buckwheat No. 1.	Philadelphia	1.85@ 2.75
Birdseye	New York	1.25@ 2.00

FUEL OIL

New York—Aug. 19, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¾c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Aug. 7, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 5.8c. per gal.; 38@40 deg., 7¼c. per gal.

Pittsburgh—Aug. 10, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil 6½c. per gal.

Dallas—Aug. 14, f.o.b. local refinery 26@30 deg., $1.75 per bbl.

Philadelphia—Aug. 13, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.59 @$1.65 per bbl.

Cincinnati—Aug. 16, tank-car lots f.o.b. local refinery, 24@26 deg., Baumé, 6½c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Aug. 16, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.35@$1.40 per bbl.; 26@30 deg., $1.40@$1.45; 30@32 deg., $1.55.

Boston—Aug. 16, tank-car lots f.o.b. 12@14 deg. Baumé 4.48c. per gal.; 28@ 32 deg., 5.9c. per gal.

New Plant Construction

Calif., Los Angeles—City c/o Bureau of Light & Power, 207 South Broadway, will build 2 story, electric distributing station, on South Corta St. Estimated cost $100,000. Work will be done with company forces.

Calif., Los Angeles—P. S. Wright, et. al. are having plans prepared for the construction of 12 story, office building, including steam heating equipment, elevator, etc., at Southeast corner 5th and Figueroa Sts. Estimated cost $1,000,000. Dodd & Richards, Track-Shops Bldg., are architects.

Calif., Monticello — Monticello Union School District, C. N. Clark, Clk., is receiving bids for 1 double acting deep well pump, one 1½ hp. motor to be operated by Kohler Light Plant; one double acting deep well cylinder, to furnish approximately 500 gal. per hour; 1 automatic electric controller, etc.

Calif., Redwood City—Hotel Woodside Co., c/o C. H. Barrett, Washington Hotel, San Francisco, Archt. is having plans prepared for the construction of 5 story hotel on Woodside acres tract, here. Estimated cost $2,000,000.

Ga., Atlanta—T. M. Armistead Estate, 1087 Peachtree St., is having plans prepared for the construction of 13 story, hotel here. Estimated cost $1,000,000. A. Ten Eyck, Forsythe Bldg., is architect.

Ill., Chicago—J. A. Biddlerman, 10 South La Salle St., is having plans prepared for the construction of 8 story, hotel and stores building, including oil heating system, 2 elevators, refrigeration plant, etc., at 4539 Sheridan Rd. Estimated cost $850,000. D. S. Klafter, 64 West Randolph St., is engineer.

Ill., Chicago — Central Manufacturing District, c/o A. Epstein, 2001 West Pershing Rd., Archt., will purchase refrigerating plant for proposed candy factory, at 3342 Iron St.

Ill., Chicago—R. F. France & Co., 155 North Clark Ct., Archts., will receive bids until Sept. 2, for 12 story, apartment, including oil heating system, 2 elevators, etc., at 3918-24 Lake Shore Dr., for M. Thorek, 850 Irving Park Blvd. Estimated cost $1,000,000.

Ill., Chicago—Friedman, Constr. Co., 80 West Washington St., will soon receive bids for the construction of a 7 story apartment, including oil heating system, electric refrigeration, elevators etc., at 5232 Harper Ave. Estimated cost $600,000. T. Bishop, 35 South Dearborn St., is architect.

Ill., Chicago—J. Glasser, 4826 Sheridan Rd., will receive bid until September 1, for the construction of a 7 story, apartment hotel, including oil heating system, 2 elevators, electric refrigeration, etc. Estimated cost $650,000. D. S. Klafter, 64 West Randoph St., is architect.

Ill., Chicago—Graham, Anderson, Probst & White, Archts., Railway Exchange Bldg., will receive bids until September 8, for the construction of a 24 story, office and stores building, including ash removal system, coal handling machinery, boilers, stokers, elevators, etc., on southeast corner of Wabash Ave. and Washington St., for Marshall Field Estate, 25 East Washington St. Estimated cost $5,000,000.

Ill., Chicago—A. Karzas, 853 East 63rd St., is having plans prepared for the construction of 12 story, theatre, hotel and stores building on East 63rd St., from Maryland Ave. to Drexel Blvd. Estimated cost $5,000,000. C. H. Crane and C. H. Betts, 32 West Randolph St., are architects.

Ill., Chicago—Syndicate, c/o B. L. Steif & Co., 307 North Michigan Ave., is having plans prepared for the construction of 12 story apartment on Northwest corner of Grace St. and Sheridan Dr. Estimated cost $2,000,000.

Ill., Oak Park—L. C. Bouchard, 160 North La Salle St., Chicago, Archt., will receive bids until September 2, for the construction of a 5 story, apartment, including oil heating system, elevator, etc., at 839 Lake St., here for Eight Hundred Thirty Nine Lake Street Building Corp. Estimated cost $500,000.

Ind., Ellettsville—City soon takes bids for steel tank, pumps, etc. for waterworks plant. Estimated cost $40,000. Hew Eng. Co., Terra Haute, is engineer.

Ia., Davenport—American Commercial & Savings Bank, 230 Main St., E. Kaufmann, Pres. is having plans prepared for the construction of 14 story bank and office building, Main St. and Third Ave., here. Estimated cost $1,500,000. Weary & Alford, 1923 Calumet Ave., Chicago, and Kruse & Klein, Kahl Bldg., Davenport are architects.

Mass., Boston—Beth Israel Hospital, c/o Densmore, LeClear & Robbins, Archts., Park Sq. Bldg., awarded contract for the construction of a 7 story hospital on Brookline Ave., to Holt-Fairchild Co., 7 Water St. Estimated cost $1,000,000.

Mich., Detroit — A. Kahn, Archt., 1000 Marquette Bldg., will receive bids about August 25, for 21 story hotel, including steam heating equipment, etc., on Fort St., for the Fort Shelby Hotel Co., Fort St.

Minn., St. Paul—Luley Abattoir Co., 567 North Cleveland Ave., is having plans prepared for the construction of 3 story, cold storage plant at Minnesota Transfer. Estimated cost $150,000. A. F. Gauger, 605 Exchange Bank Bldg., is engineer.

Neb., Douglas—F. M. Learned, village Clerk will receive bids until, Sept. 9, for waterworks improvements, including single stroke deep well pump, 60 g.p.m. capacity; 2 stroke deep well pump, 100 g.p.m. capacity; and 7½ hp. 3 phase, 220 v. 12,000 r.p.m. A. C. motor and 10 hp. 3 phase 220 v., 1,200 r.p.m. A. C. motor. Henningson Eng. Co., National Bldg., Omaha, is engineer.

Neb., Lincoln—Realty Syndicate, W. E. Sharp, Pres. awarded contract for the construction of 15 story, office building at 13th and N Sts., to Selden Breck Constr. Co., 205 Arthur Bldg., Omaha, Neb. Estimated cost $1,200,000.

N. Y., Albany—Eloise Corporation, 51 State St., awarded contract for the construction of an apartment house including 2 elevators, at Western and Lake Aves., to Cassidy & Gallagher, 73 Elm St. Estimated cost $750,000.

N. Y., Albany—Metropolitan Realty Co., awarded contract for the construction of a 10 story apartment, at State, Eagle and Howard Sts to J. P. Sewell, 372 Hudson Ave. Estimated cost $2,000,000.

N. Y., Farmingdale—President of Board of Trustees, State Institute Applied Agriculture, will receive bids until September 10, for air compressor of State Institute, here.

N. Y., New York — Bellevue & Allied Hospitals, foot of East 26th St., J. McGrath, Pres., are having plans prepared for the construction of a 5 story, hospital, on Southern Blvd. Estimated cost $1,500,000. Starrett & Van Vleck, 393 7th Ave., are architects.

N. Y., New York — H. I. Chanin, 285 Madison Ave., will build 45 story, office building, on Lexington ave. Estimate cost $8,000,000. Work will be done by separate contracts, under owner's supervision.

N. Y., New York—One Hundred Eleven John Street Corp., A. E. Hoyt, Pres., is having plans prepared for the construction of 18 story, office, at John, Cliff and Pearl Sts. Estimated cost $2,000,000. J. B. Peterkin, 285 Madison Ave., New York City, is engineer and architect.

N. Y., New York—One Hundred Forty-Five West 82nd Street Corp., c/o W. H. Jackson, Archt., 1841 Broadway, is having plans prepared for the construction of a 15 story, apartment, on West 82nd St. Estimated cost $1,350,000.

O., Avon Lake—Village is having plans prepared for the construction of a low service pump house, with coagulation basins, four mg. capacity motor driven pumps, and two 1½ mg. gasoline driven pumps, etc. G. B. Gascoigne, Leader Bldg., Cleveland, is engineer.

O., Dayton — At office Constructing Quartermaster Wright Field, will receive bids until September 9 for constructing boiler house, with mechanical equipment, etc. at Wright Field, here.

Okla., Blackwell — City voted $198,000 bonds for water purification plant, including pumping equipment, etc. W. Ritzhaupt, Blackwell, is engineer.

Okla., Healdton—City Council is having preliminary plans prepared for deep wells with pumping equipment,, etc. Estimated cost $35,000. Engineer not selected.

Okla., Seminole—Water Works Dept., E. A. Broaduax, Purch. Agt., is in the market for 70 g.p.m. deep well pump and 15 hp. motor.

Okla, Talihina — City plans election to vote $60,000 bonds for waterworks improvements, including pumping equipment, etc. P. H. Foster, is chairman of City Council.

Okla., Milburn—Oklahoma Gas & Electric Co., Ins. Bldg., Oklahoma City, has purchased municipal electric light plant here and is in the market for additional equipment. Estimated cost $35,000. Private plans.

Tenn., Knoxville—City will receive bids until September 9, for construction of municipal waterworks plant, including pumps, piping, etc. Alvord, Burdick & Howson, 8 South Dearborn St., Chicago, Ill., are consulting engineers.

Tenn., Nashville — Board of Public Works, at office city clerk, will receive bids until September 10, for the construction of superstructure of boiler house, with stack, piping, etc. J. N. Chester, Union Bank Bldg., Pittsburgh, Pa., is engineer.

Tex., Canten—City plans the construction of a pumping plant, reservoir, etc. Estimated cost $25,000. J. White, Tyler, is engineer.

Tex., Harlingen—City plans installing additional 750 hp. unit in power house, here. Estimated cost $20,000. E. C. Bennett, is superintendent of utilities.

Tex., Kerens—P. H. Brister plans irrigating 450 acres, by pumping water from Trinity River. Owner is in the market for large crude oil or gas engine, pumps, etc. Estimated cost $30,000.

Tex., Orange — H. J. L. Stark, plans irrigating 32,200 acres cutover land in Newton County with water from Sabine River. Estimated cost $75,000. Owner is in the market for engines, pumping equipment, etc.

Wis., East Troy—City G. A. Kurzrok, clk., voted $20,000 bonds for additional water supply, including pumping machinery, etc. Engineer is not selected.

Wis., Hudson—Willow River Power Co. is having plans prepared for the construction of Willow River Power House, here. A. C. Woods & Co., Rockford are steel designers.

Wis., Mendota—State Board of Control, Capitol, Madison, A. W. Bagley, Secy., is having plans prepared for the construction of refrigeration plant, at the State Hospital for Insane, here. Estimated cost $40,000. Owner is in the market for refrigerating equipment. A. Peabody, State Capitol, Madison, is architect.

Wis., Milwaukee—Department of Public Works, R. Stoelting, Comr., will receive bids until August 27, for 400 hp. horizontal water tube boiler, with furnace, mechanical stoker, superheater and forced draft apparatus, for North Point Pumping Station, here.

Wis., Shawano — Wisconsin Power & Light Co., 16 North Carroll St., Madison, awarded contract for the construction of hydro electric plant on Wolf River, here, to L. E. Meyers, Co., 53 West Jackson Blvd., Chicago, Ill. Estimated cost $200,000.

Ont., Ottawa — Ottawa Electric Co., Sparks St., is having plans prepared for the construction of 9 story office building on Sparks St. Estimated cost $650,000. J. A. Evart, Jackson Bldg., is architect.

Ont., Toronto—Central Sites Development Co., Toronto, awarded contract for the construction of a 5 story, stores and office building, at Bloor and Bay Sts., to W. H. Yates Constr. Co., 95 East King St. Estimated cost $1,250,000. Steam heating system and 2 elevators to be installed.

N. B., St. John—New Brunswick Electric Power Commission, St. John, awarded contract for the construction of a dam at Lock Alva., for Musquach Development, to Saab & Co., St. John, $23,034.